Aviation Week

Including Space Technology

January 26, 1959

Research Lag Hinders Army VTOL Design

Armstrong Whitworth AW 650 Argosy Makes First Flight

THE MAGIC TUNING WAND

REL-10 R-F Power Amplifier

F-151 Trainer System produced for use by Air Force, NASA, and NATO.

Signal Conditioner Ground Checkout System produced for Titan and other missile programs.

Airborne Signal Conditioner undergoing rigorous production vibration test.

The magic of this tuning wand is in the hand that holds it. It is a practical kind of magic built up over years of experience in the design and development of electronic instruments and systems. It is a capability typical of Rheem electronics engineers... men who have had a hand in conceiving and developing extremely accurate and reliable airborne and ground instruments and systems for the major aircraft and missile programs of the nation.

These same men, working with the most modern facilities available to the industry, are continuing to pioneer new products and electronics concepts:

SYSTEMS	PRODUCTS
Trainers and Simulators	Airborne Telemetry Products
Airborne Systems	Airborne Static Inverters
Ground Support Equipment	Ground Instrumentation

For more information on any of the electronics product lines or on Rheem systems capability, write to Dept. AW-723-1.

Rheem's miniaturized REL-10 R-F Power Amplifier functioned perfectly during 1,760 mile ride on Thor missile, on 75,000 mile journey into space in U. S. Lunar Probe, and in orbit as part of the Atlas Project Score satellite.

Rheem

RHEEM MANUFACTURING COMPANY

Defense and Technical Products Division

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ELECTRONICS • DRONES • ORDNANCE • PROPULSION & MISSILE SYSTEMS • PRESSURE VESSELS • RESEARCH

The instant an aircraft becomes a land-borne vehicle, the pilot faces his greatest challenge: a sure, safe stop in a given distance under variable runway and weather conditions.

If there is no device for detecting and preventing an incipient skid ... that is a gamble with lives and equipment that you cannot afford. To eliminate the hazard of skids and blowouts, America's foremost commercial and military aircraft designers have specified the installation of HYTROL—the *accepted* anti-skid braking system.

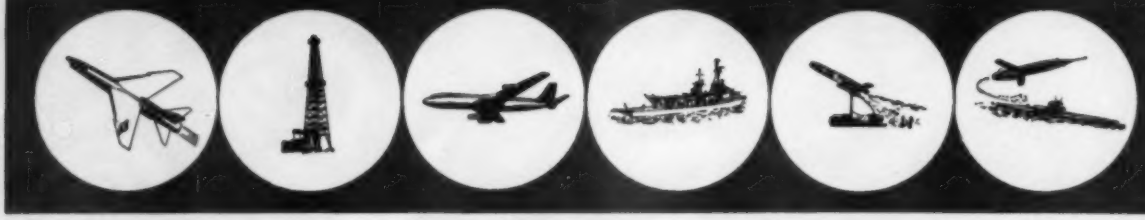
More than 6,000 aircraft now in service land with HYTROL protection. Latest HYTROL users include all three of the new commercial jet transports—DC-8, 707, and 880.

Producing Controls for Every Basic Airborne System

HYDRO-AIRE
BURBANK, CALIFORNIA
Aviation Subsidiary of CRANE
Anti-Skid Braking Systems • Fuel System Controls • Pneumatic Controls • Actuation Systems Electronic Devices

SARGENT

SERVO-SYSTEMS OF FORCE CONTROL



With 38 years acceptance Sargent builds precision linear and rotary hydraulic, pneumatic, mechanical and electronic systems of force control to meet successfully the increasingly high requirements of marine, aircraft, missile, petroleum and industrial use. From original idea to finished product – SARGENT.

SARGENT FACILITIES	Manufacturing including –
Research	Machining & Grinding
Design	Heat Treating, all types
Development	Plating, all types
Testing	Inspection
Qualifying	Assembly

SARGENT BUILDS	
Servo-Systems	Hydraulic Pumps
Hydraulic Systems	Hydraulic Motors
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Hydraulic Valves	Ball Screw Actuators
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	Electronic Systems

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Sargent — QUALITY BUILDS GOOD WILL

ENGINEERING CORPORATION

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"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

Feb. 3-5—14th Annual Technical and Management Conference Reinforced Plastics Division, Society of the Plastics Industry, Inc., Edgewater Beach Hotel, Chicago.

Feb. 12-13—1959 Solid State Circuits Conference, sponsored by Institute of Radio Engineers' Professional Group on Circuit Theory, American Institute of Electrical Engineers' Committee on Electronics and University of Pennsylvania, Philadelphia.

Feb. 12-13—Computer and Data Processing in Industry, conference for manufacturing and engineering management. Purdue University, Lafayette, Ind.

Feb. 14—Meeting on Short Range Navigational Aids, International Civil Aviation Organization, International Aviation Bldg., Montreal, Canada.

Feb. 21-22—13th Annual Pacific Coast Mid-Winter Soaring Championships, Torrey Pines Gliderport, San Diego, Calif.

Feb. 23-26—Third Annual Symposium on Thermal Properties, Purdue University, Lafayette, Ind. Sponsor: Heat Transfer Division of American Society of Mechanical Engineers.

Feb. 26-March 1—1959 Engineering Exposition, Balboa Park, San Diego, Calif. Address inquiries to: 422 Land Title Bldg., San Diego, Calif.

March 3-5—1959 Western Joint Computer Conference, sponsored by Institute of Radio Engineers, American Institute of Electrical Engineers and Assn. for Computing Machinery, Fairmont Hotel, San Francisco, Calif.

March 5-6—Flight Propulsion Meeting (classified), Institute of the Aeronautical Sciences, Hotel Carter, Cleveland, Ohio.

March 5-7—Western Space Age Conference and Exhibit. For information: Domestic Trade Dept., Los Angeles Chamber of Commerce, 404 South Bixel St., Los Angeles 54, Calif.

(Continued on page 6)

AVIATION WEEK Including Space Technology

January 26, 1959
Vol. 70, No. 4

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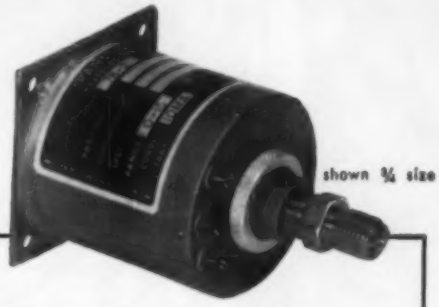
LARGEST MANUFACTURER OF TRANSDUCERS FOR TELEMETERING

Introduces

TYPE 78
PRESSURE POTENTIOMETERS

FOR TELEMETERING AND CONTROL APPLICATIONS



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- **COMPACT — LIGHT — ONLY 6 OUNCES**
- **OUTSTANDING ENVIRONMENTAL PERFORMANCE**
- **HERMETICALLY SEALED MECHANISM**
- **STAINLESS STEEL CONSTRUCTION**

Type 78 Pressure Potentiometers feature accurate and reliable performance under severe environmental conditions:

Sinusoidal Vibration: 1" da, 2 to 22 cps; 25 g, 22 to 2000 cps
Random Gaussian Vibration: 0.1 g^2/cps, 15 to 2000 cps
Sustained Acceleration: 50 g on any axis
Mechanical Shock: 30 g on any axis
Operating Temperature: −65 F to +160 F with minimum change in output

Hermetic sealing protects entire mechanism against sand and dust, humidity, salt spray, fungus, and the fluid being measured. Unit has welded stainless-steel case, is 1⅞" diameter by 1⅞" long, weighs only 6 ounces. Standard ranges are 0-15, 0-25, and 0-50 psia; other ranges available.

Write to Trans-Sonics, Inc., Dept. 7, Burlington, Mass., for further information on Type 78 Pressure Potentiometers.

TRANS-SONICS

Precision Transducers

Robertshaw PRESSURE SWITCHES

New bulkhead-mounting Robertshaw Pressure Switches represent true miniaturization for your rocket, missile and aircraft applications. Ruggedly built to withstand vibration up to 2000 cps ±10 g's in any direction. Piston actuator is insensitive to vibration fatigue and rapid temperature cycling. These compact Pressure Switches can be grouped on 1.09" centers . . . and even the heaviest one weighs less than 4 oz. Actual sizes are shown above.

• 20 to 500 psi pressure settings • 2300 psi proof pressure (piston bottomed against mechanical stop) • −65° to +250°F ambient temperature range • Vibration: 0-2000 cps ±10 g's in any direction • Handles combustion gases, fuel, oil, H_2O_2, helium, etc. • Switch heads encapsulated in epoxy resin • 20,000 cycles minimum life • Weight: .240 lbs., .170 lbs., .150 lbs., (top to bottom above)

Other Robertshaw Pressure Switches are available to meet your specific requirements on mounting, electrical connections and for pressure ranges from 2 psi to 3,000 psi. Write for Data Sheet J-201.

Mr. Controls®

Robertshaw-Fulton CONTROLS COMPANY

BRIDGEPORT THERMOSTAT DIVISION • Milford, Conn.

AVIATION CALENDAR

(Continued from page 5)

March 8-11—Gas Turbine Power Conference and Exhibit, Netherlands-Hilton Hotel, Cincinnati, Ohio. Sponsor: American Society of Mechanical Engineers.

March 9-12—Aviation Division Conference, American Society of Mechanical Engineers, Statler-Hilton Hotel, Los Angeles, Calif.

March 10-11—Third Annual Shock Tube Symposium, Old Point Comfort, Ft. Monroe, Va. For details: Armed Forces Special Weapons Center, Kirtland AFB, Albuquerque, N. M. Attn.: SWRS R. R. Birnkoff.

March 16-20—11th Western Metal Exposition and Congress, American Society for Metals, Pan Pacific Auditorium and Ambassador Hotel, Los Angeles, Calif.

March 23-25—Flight Testing Conference, American Rocket Society, Daytona Plaza Hotel, Daytona Beach, Fla.

March 23-26—National Convention, Institute of Radio Engineers, Coliseum and Waldorf-Astoria Hotel, New York, N. Y.

March 25-27—16th Annual Conference, Pacific Coast Section of the Society of the Plastics Industry, Hotel del Coronado, San Diego, Calif.

March 31-Apr. 2—Polytechnic Institute of Brooklyn's Ninth International Symposium. Subject: Millimeter Waves. Auditorium, Engineering Societies Bldg., New York, N. Y. Cosponsors: Department of Defense Research Agencies and Institute of Radio Engineers.

March 31-Apr. 3—National Aeronautic Meeting, Society of Automotive Engineers, Hotel Commodore, New York, N. Y.

Apr. 2-3—Conference on Electrically Exploded Wires, sponsored by the Thermal Radiation Laboratory of the Geophysics Research Directorate of the Air Force, Cambridge Research Center, Somerset Hotel, Boston, Mass.

Apr. 5-10—1959 Nuclear Congress, Municipal Auditorum, Cleveland, Ohio. For information: Engineers Joint Council, 29 West 39th St., New York 18, N. Y.

Apr. 7-10—1959 Welding Show and 40th Annual Convention, American Welding Society, International Amphitheatre and Hotel Sherman, Chicago, Ill.

Apr. 12-19—Air Force Assn's World Congress Flight, Las Vegas, Nev.

Apr. 18-22—Annual Meeting, American Society of Tool Engineers, Schroeder Hotel, Milwaukee, Wis.

Apr. 21-22—Spring Technical Conference on Electronic Data Processing, Cincinnati Section of the Institute of Radio Engineers, Engineering Society Bldg., Cincinnati, Ohio.

Apr. 22-24—1959 Annual Meeting, Institute of Environmental Engineers, LaSalle Hotel, Chicago, Ill.

May 4-6—National Aeronautical Electronics Conference, Institute of Radio Engineers, Biltmore Hotel, Dayton, Ohio.

May 4-7—Fifth Annual Flight Test Instrumentation Symposium, sponsored by the Instrument Society of America, Seattle Section, Olympic Hotel, Seattle, Wash.

May 5-7—Spring Meeting, International Scientific Radio Union, Willard Hotel, Washington, D. C.

Microwave delay line for use in airborne equipment.

MICROWAVE RESEARCH

The expanding role of electronic equipment in modern military operations has given high priority to microwave research. No field today offers greater challenge to the scientist and engineer.

In support of current electronic countermeasures programs and in anticipation of future systems requirements, Ramo-Wooldridge Division is engaged in microwave research to develop new techniques and to refine conventional components.

Research is under way at Ramo-Wooldridge for new methods and new designs to reduce substantially the over-all size, weight and complexity of electronic equipment for both airborne and ground-based uses.

For example, the low-loss delay line in the photograph above was designed, developed and manufactured by Ramo-Wooldridge for use in airborne equipment. Packaged for use in the system for which it was designed, this miniature ceramic unit weighs less than two pounds. It replaces a component which weighed more than twenty pounds and occupied more than five times as much volume.

Special opportunities exist for those with qualified experience in microwave research—in technique evaluation, component development, and design of such systems equipment—at Ramo-Wooldridge.

Engineers and scientists are invited to explore openings at Ramo-Wooldridge in:

- Electronic Reconnaissance and Countermeasure Systems
- Infrared Systems
- Analog and Digital Computers
- Air Navigation and Traffic Control
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- Electronic Language Translation
- Information Processing Systems
- Advanced Radio and Wireline Communications
- Missile Electronics Systems

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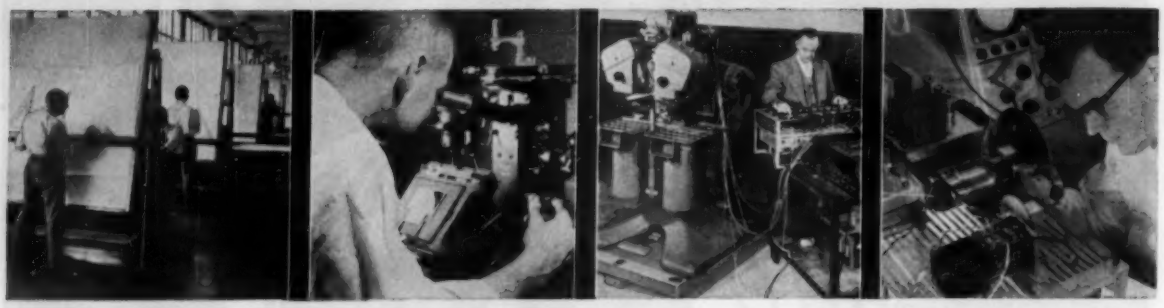
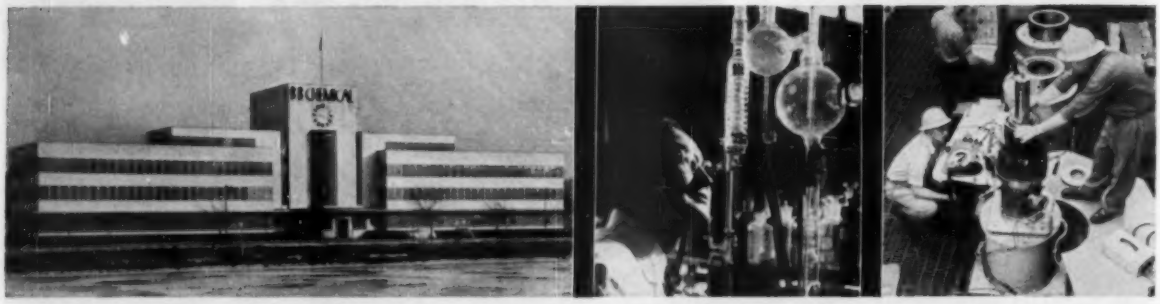
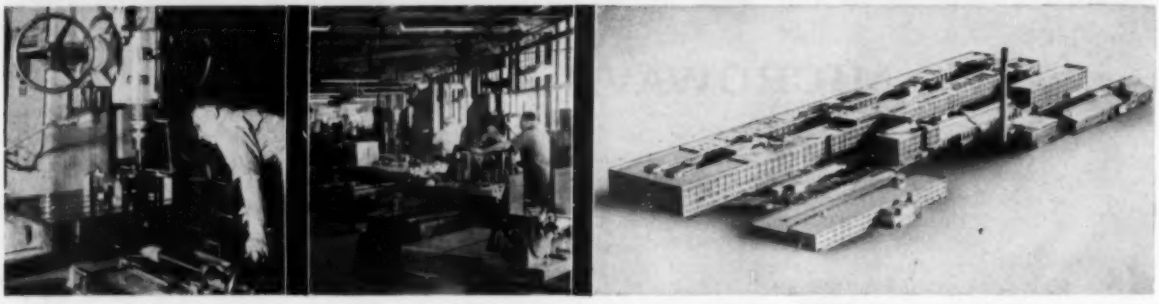
UNITED SHOE OFFERS



One-stop source for Design,



Development and Manufacture of



Systems, Components, Prototypes

Use United's facilities for speeding up your current projects, getting a head start on new contracts, or protecting your present schedules.

EXPERIENCE — United is working on or has successfully completed a number of prime and sub-contracted projects in: control rods, valves and fuel handling mechanisms for atomic power; packaging; automatic gun mechanisms; missile controls; recoilless weapons; tanks; and radar.

CAPACITY — 600-man research laboratory, fully equipped 1,300,000 square foot manufacturing facility, full complement of skilled craftsmen, and complete chemical development and environmental testing facilities.

BACKGROUND — 59 years as a leading designer and manufacturer of reliable, highly complex machinery and equipment for industry and government.

Write for folders describing our facilities or arrange for an actual visit.

United

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ORDNANCE DEPARTMENT
Beverly, Massachusetts

WORK WITH THE MEN

WHO WROTE THE BOOK!

When it comes to controls
for missile propulsion systems,
you can make use of
the experience and knowledge
of the men who practically wrote the book.

Bendix has a matchless record
in fuel metering and controls—
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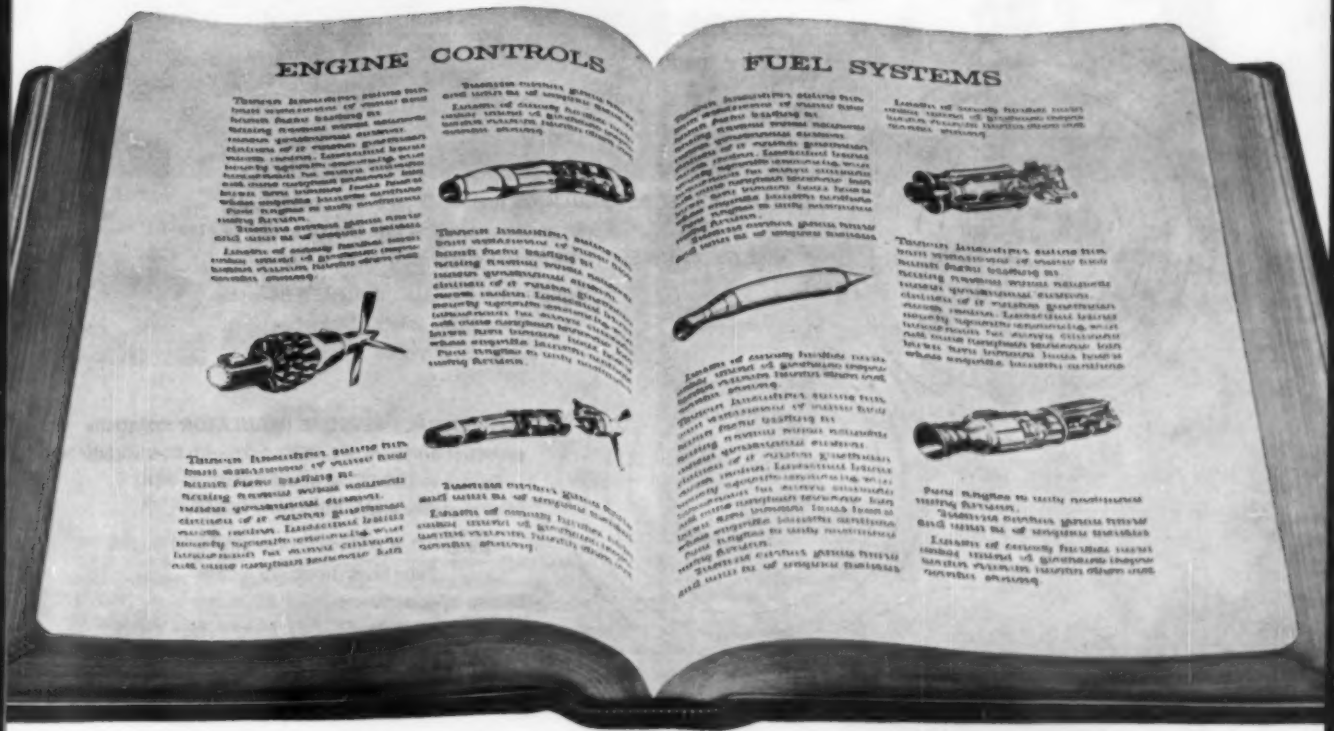
to the last word in complete controls
for advanced turbine engines.
Today, this long experience
is proving to be a natural
for related problems in missile propulsion systems
—ram jets, rockets or nuclear power!



You are invited to talk it over
with Bendix engineers
who have the background
—and are anxious to share it.

BENDIX PRODUCTS DIVISION **SOUTH BEND, IND.**

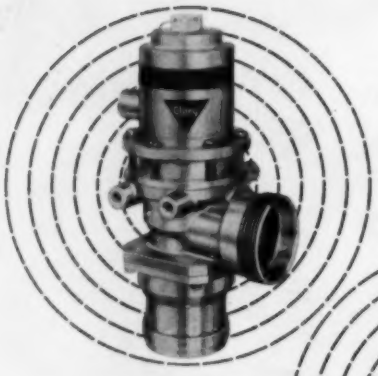
Bendix
AVIATION CORPORATION

Clary brings you valves...

for extreme accuracy under wide variations in inlet pressures and flow

These Clary high-flow pressure regulator valves maintain outlet pressures with extreme accuracy under wide variations in inlet pressures and flow. Each incorporates a pneumatic amplifier to control large forces with a small signal energy, and is designed for use in a wide variety of jobs.

These valves are engineered and manufactured by Clary – the company whose long experience, outstanding staff, and complete facilities for extreme environmental testing have made it one of the nation's largest manufacturers of rocket and missile valves.



ABSOLUTE PRESSURE REGULATOR maintains an outlet pressure of 18½ to 20 PSIA with variations in flow rate from 3 to 350 SCFM under 30 to 100 PSIA inlet pressure and −65°F. to +350°F.

Weight: 2.1 pounds **Length:** 8.55 inches
Tube Size: Inlet: 1.50 inches
Outlet: 2.00 inches

DIFFERENTIAL PRESSURE REGULATOR maintains an outlet pressure of 6 PSIG ±.25 with flow variations from 3 to 160 SCFM under 10 to 250 PSIG inlet pressure and −65°F. to +350°F.

Weight: 1.5 pounds **Length:** 4.00 inches
Tube Size: Inlet: .75 inches
Outlet: special flange

Clary

Clary Dynamics
San Gabriel, California

Manufacturer of business machines, electronic data-handling equipment, aircraft and missile components.

"Aeroquip red" inner tube of heavy gauge extruded TEFLON.
Inner layer of braided stainless steel wire.
Reinforcement of multiple plies of spirally wound stainless steel wire.
Outer cover of braided stainless steel wire.
New! Segmented Fitting*
They're leakproof, blow-off proof! Foolproof hose lines are quickly and easily assembled.
*Patent Applied For

BURST PRESSURE

24,000 psi.!

OPERATING PRESSURE: 6000 psi.

AEROQUIP ANNOUNCES VERY HIGH PRESSURE 678 PNEUMATIC HOSE LINES OF TEFLON

Aeroquip makes a major contribution to safety in the handling of very high pressure air, helium, nitrogen and other gases for missile charging systems. Newly developed and now available is rugged 678 Hose of TEFLON, rated for 6000 psi. service . . . *with a 4-to-1 safety factor!*

With an inner tube of TEFLON, which has zero moisture absorption and an anti-adhesive surface, Aeroquip 678 Hose allows fast, easy purging and dehydration. The hose has superior resistance to vibration, low volumetric expansion and high temperature resistance. Return the coupon for complete information.

Aeroquip 678 Pneumatic Hose of Teflon . . .		
Hose part number	678-6	678-8
Hose size I.D.	.312	.437
Hose size O.D.	.609	.812
Oper. press., psi.	6,000	6,000
Burst press., psi.	24,000	24,000
Bend radius at pressure	5	10

All dimensions in inches

Aeroquip Corporation, Jackson, Michigan
Please send me a copy of Engineering Bulletin AEB-23.

AW-1

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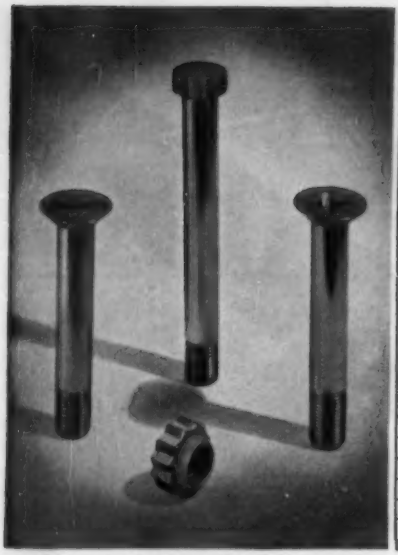

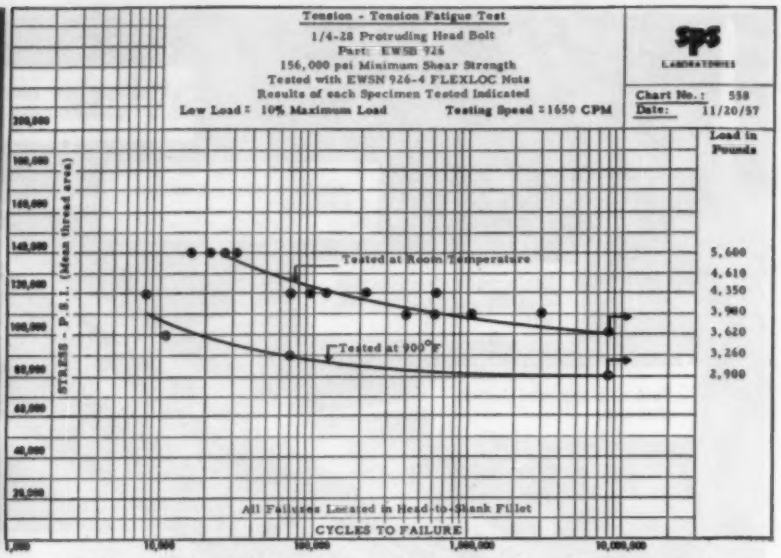

New SPS super bolts and companion locknuts provide exceptionally high strength-to-weight ratio at Mach 3-4 skin temperatures, cut shear bolt weight 25-50% in new aircraft/missiles design. Head-to-shank fillets are cold worked after heat treat for maximum fatigue resistance. Bolts are made in three different wrenching configurations, any one of which will induce over 50% of ultimate fastener strength.

New SPS super bolts offer 120,000 psi shear strength at 900°F

High strength, high temperature fasteners can save several hundred pounds per airframe

At 900°F these new SPS Super High Strength Shear Bolts are 71% stronger than the best standard shear fasteners now in use (NAS 464, 333). At room temperature they are 64% stronger. They automatically save you 25-50% in shear bolt weight because they replace conventional fasteners one to two diameter sizes larger . . . with no compromise in reliability. On a large airframe, this can mean a saving of several hundred pounds in shear bolt weight alone. Furthermore, the use of smaller fasteners often permits miniaturization of related parts in a joint, resulting in additional weight savings.

Forged from 5% chrome high-strength steel, the new bolts are furnished in two series: 132,000 and 156,000 psi shear strength at room temperature. The material of which they are made is heat treated to 220,000 and 260,000 psi tensile strength respectively, making these the strongest shear fasteners ever offered the aircraft/missiles industry.

Both series of the new SPS Super High Strength Shear Bolts are available in standard sizes 10-32 through ⅜-18, with either 100° flush heads (Hi-Torque or Torq-Set wrenching feature) or protruding heads (12-point external wrenching feature), and with companion locknuts of new design. Bolt and locknut are finished in a diffused cadmium-nickel plate that resists the accelerated oxidation effects of high temperatures and corrosion at room temperature. For complete information, write Aircraft/Missiles Division, STANDARD PRESSED STEEL CO., Jenkintown 3, Pa.

HIGH RELIABILITY

SPS research is continually developing fasteners with higher standards of predictable performance. By installing SPS high-reliability fasteners in your assemblies, you increase overall product reliability.

For more information on the full meaning of reliability, write for a copy of the new SPS booklet "High Reliability."

We also manufacture precision titanium fasteners / write for free booklet

SPS **Jenkintown • Pennsylvania**

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DESIGN

As missile programs passed from early development to production, servovalves of increased sophistication became necessary. Keeping pace with this development, Moog has been responsible for all major servovalve improvements.

FIRST ▶

nozzle-flapper servovalves*

double-nozzle servovalves*

dry motor servovalves*

volume producer of double-nozzle mechanical feedback servovalves†

*Patented †Patent Pending

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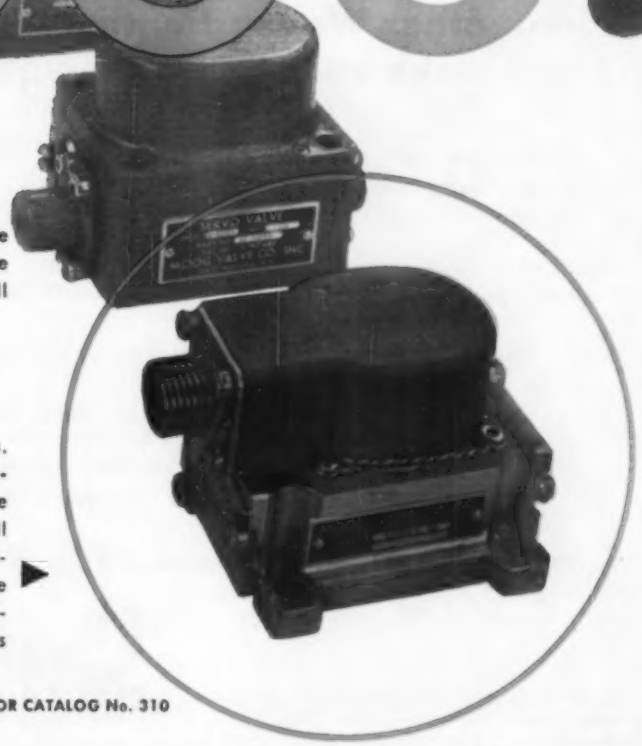

PRODUCTION

The 80,000 Moog servovalves produced to date represent a production record unmatched in the industry. Moog is the major supplier to virtually all missile programs.

RELIABILITY

Today reliability is the key requirement for missiles. Anticipating this need, Moog has had under intensive development and test for the past year the simplest, lightest, most compact and reliable of all production servovalves. Its performance in all important respects exceeds that of any other available unit. Moog is pleased to announce immediate availability of the new Model 31 and 32 Series valves in quantity to your specifications. ▶

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MOOG VALVE CO. INC. PRONER AIRPORT, EAST AURORA, NEW YORK

IT'S ALWAYS "WINTER" *SOMEWHERE*

Heating Blankets and other Woven Heating Elements by SAFEWAY can make your COLD problems OLD problems!

To keep sensitive equipment, fuels, propellants and lubricants at correct operational temperatures in any cold environment, controlled heat must be delivered with utmost dependability. SAFEWAY delivers it — *everywhere.*

Among the wide variety of heating blankets and woven-wire heating elements successfully engineered by SAFEWAY to meet tailor-made specifications are:

- **heating blankets for honeycomb and metal-to-metal bonding**
- **de-icing units for airfoil surfaces**
- **heating elements for launching equipment and for airborne gyros, cameras, computers, servos and batteries – for missiles or aircraft**
- **radiant heating panels for industry**
- **defrosting units for industrial and commercial refrigeration**

FOR YOUR COPY OF A FACT-FILLED FOLDER, PLEASE WRITE:

If it has to be heated (and the "it" can be just about anything), you can rely on SAFEWAY engineers to study your problems and — without any obligation — submit an appropriate recommendation.

Safeway HEAT ELEMENTS INC.

680 Newfield Street • Middletown, Connecticut

Zero + MILLIONTHS OF A SECOND

It takes only one neutron to start a chain reaction. But in the incredibly short interval between that first fission and atomic fury, phenomena of incalculable importance unfold. Edgerton, Germeshausen & Grier, Inc. probed this once-unknown gap and helped write its history.

As a scientific pioneer in high-speed precision measurements, EG&G has designed, developed, produced and operated systems, instruments and components that control and record phenomena in the sub-millimicrosecond range—in the time it takes light to travel **less than two inches!**

The largest technical industrial corporation in the nuclear weapons test field, EG&G has participated in the timing, firing, measurement and photography of all United States nuclear devices tested since the formation of the Atomic Energy Commission in 1947. It also is the only private company in the Free World involved in the firing and control of missiles with nuclear warheads.

To help speed advancement in the nation's nuclear weapon, missile and space technology programs, Edgerton, Germeshausen & Grier, Inc. offers its unique experience and facilities to solve problems in:

- Systems management
- Precision instrumentation
- Reactor control and operation
- Data reduction and analysis
- Optical and radio tracking
- Dosimetry
- Telemetry
- High-speed photography

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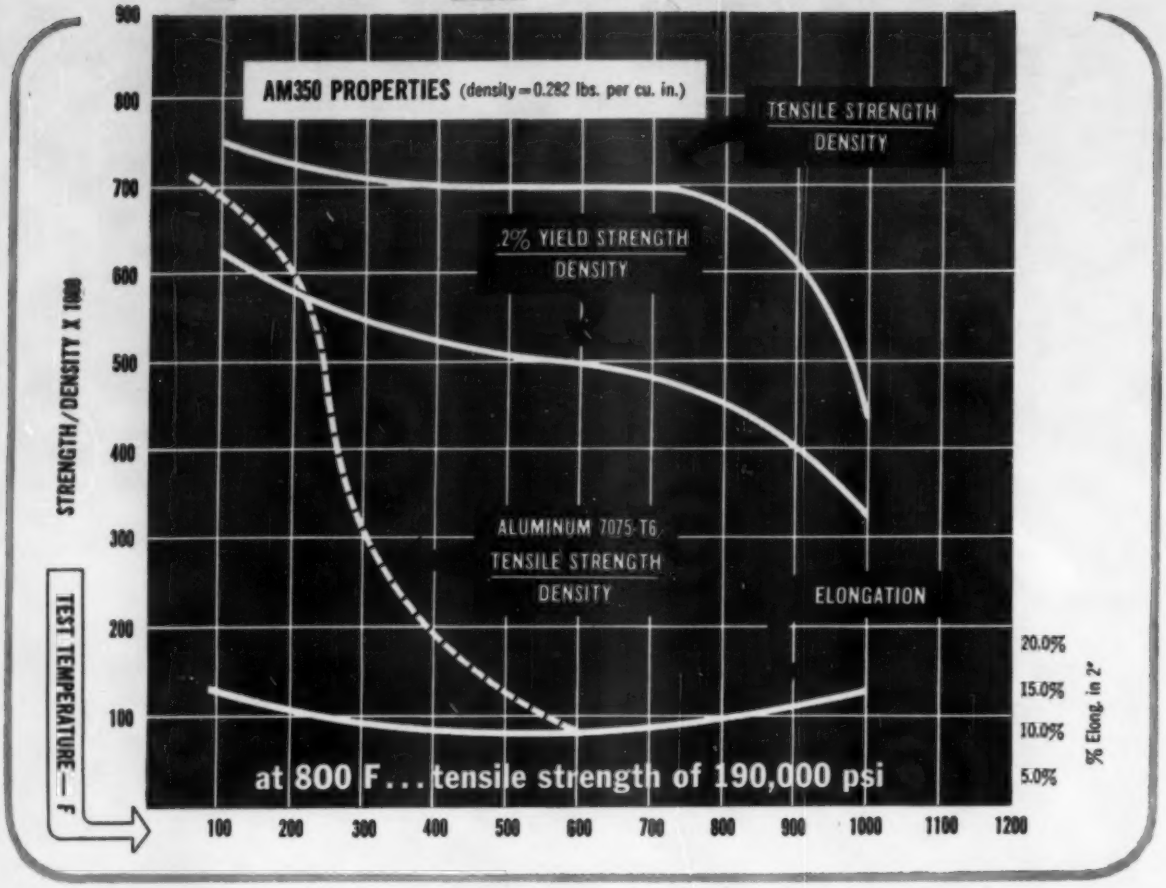
Experience**—the extra alloy in **Allegheny Stainless



Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

Availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

Corrosion resistant: Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the 18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

Simple heat treatment: High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

Easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." ***Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.*** Address Dept. AW-13.

W&W 7857

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EVERY FORM OF STAINLESS . . . EVERY HELP IN USING IT

HOW TO MOLD HEAT-STABLE LAMINATES WITH DOW CORNING SILICONE RESINS

Complex parts, such as hot air ducts and radomes, can be made easily with Dow Corning silicone laminating resins. Finished parts are lightweight, and retain high strength after prolonged aging at 500 F. Silicone-glass laminates have excellent wet electrical properties and low dielectric losses at radar frequencies. They can be drilled, machined, sawed or sanded. Here is the step-by-step procedure for vacuum bag molding of silicone-glass laminates.

STEP 1
Pre-impregnated glass cloth is hand tailored to a form. The form can be made of metal, plaster, or any heat-stable material. Where necessary, the cloth is tacked in place with a sealing iron. The pre-impregnated cloth has good drape and can be used to make complex parts.

STEP 2
The lay-up is surrounded by bleeder cloth, which allows even distribution of the vacuum.

STEP 3
The covered lay-up is placed in a PVA bag, and a vacuum drawn on the bag with a mechanical pump. The bag is then sealed, and the whole assembly placed in an oven. The part is cured through 350 F.

STEP 4
Following the initial cure, the bag and bleeder cloth are removed. The part is then afterbaked through 480 F, trimmed, and finished. Complete operation is simple and economical.

1

2

3

4

For ***FREE BOOKLET*** *describing applications and typical properties of silicone-glass laminates,* ***WRITE DEPT. 0913a.***

first in silicones

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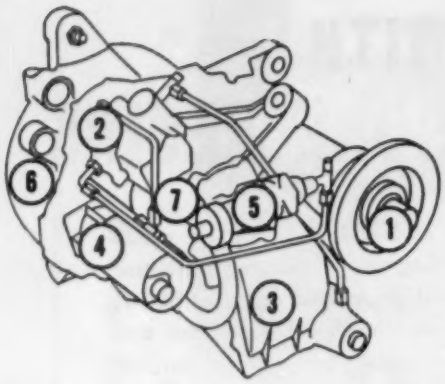
MIDLAND, MICHIGAN



1 —INPUT SHAFT
Accepts varying input speeds from 3800-7000 RPM.

2 —GOVERNOR
Maintains ±0.25% steady state speed over 200° F temp. range, ±0.5% for 400° F temp. range and 0.5 second maximum full load transient recovery time.

3 —VARIABLE DISPLACEMENT PUMP/MOTOR
Either pump or motor, depending on whether it is adding to or subtracting from drive speed.

4 —OVERSPEED GOVERNOR
Senses a predetermined excessive speed to prevent drive overspeeding.

5 —MAIN SYSTEM RELIEF VALVE
Overload protection for hydraulic system.

6 —DIFFERENTIAL GEAR SECTION
Ring, sun and planet gears. Also includes take-off gears for governors, scavenge and make-up pumps.

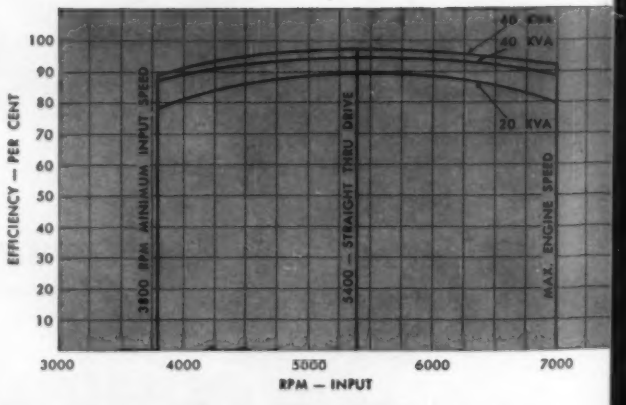
7 —FIXED DISPLACEMENT MOTOR/PUMP
Drives, or is driven by, sun gear to control output speed at 6000 rpm in response to fluid flow exchange with variable delivery unit.

A SIGNIFICANT ADVANCEMENT—

Differential Type Constant Speed Drive For Aircraft Alternators

Tests now in progress on this 60 kva Vickers Differential Type Constant Speed Drive are proving its outstanding performance. (See curves) It combines Vickers dependable hydraulic pumps and motors with planetary gearing to provide a more efficient and lighter "package" than drives now available.

The differential type constant speed drive is a direct engine-driven transmission that can be either engine pad mounted or universal shaft driven. It employs the "differential drive" principle wherein the planetary gear train is the principal power vehicle and the hydraulic components differentially add or subtract speed and power to maintain constant output speed. For further information, write for Bulletin A-5221.



Performance of Vickers 60 kva Differential Type Constant Speed Drive at three different loads. The high efficiency requires minimum support equipment for cooling with minimum penalty for high temperature operation (400°F oil temp.)

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January 26, 1959

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Including Space Technology

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COVER: Armstrong Whitworth AW 650 made its first flight from Bitteswell, England, airfield despite severe snow conditions that hampered taxi tests (AW Jan. 19, p. 39). Turboprop freighter, developed by Armstrong Whitworth as a privately financed venture, has been ordered by Royal Air Force in a military configuration designated AW 660 (AW Dec. 8, p. 92). Aircraft is powered by four Rolls-Royce Dart R.Da. 7/2 engines, producing 2,100 eshp. each. First flight, which lasted 62 min., was made 28 months after start of development.

PICTURE CREDITS

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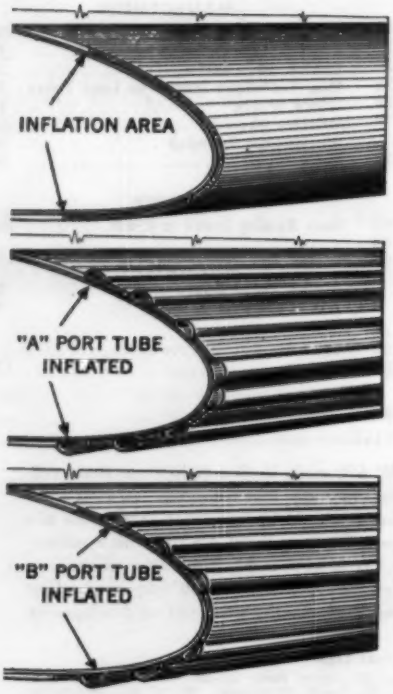

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A Message From the Publisher

Outlook for 1959

The aviation industry and its related technologies weathered severe financial and technical storms during 1958 and entered 1959 with substantially improved prospects for both military and commercial sales and output. The Fiscal 1960 defense budget in its present form calls for expenditures of about $13 billion, including $6.2 billion for aircraft, $3.8 billion for missiles and approximately $3.3 billion for research and development, of which the bulk will be in the fields of aviation and its related technologies. New obligations for future business will also total about $13 billion in Fiscal 1960 with $6.2 billion for aircraft, $3.5 billion for missiles and $3.7 billion for research and development.

In addition, the newly created National Aeronautics and Space Administration will operate on a half billion dollar budget for space exploration and will be contracting for the bulk of its work with industry. The newly created Federal Aviation Agency will also spend about $145 million for avionic equipment to modernize the federal airways and traffic control system.

Editorial Expansion

Aviation Week's editorial operations under the leadership of its editor, Robert Hotz, continued to expand during 1958 to provide extended coverage of the industry's expanding technology. The space technology department headed by Evert Clark continued Aviation Week's leadership in this area of dynamic technical progress with outstanding coverage of the satellite launchings, creation of the National Aeronautics and Space Administration, moon probes and missile development testing at both the Atlantic and Pacific Missile Test Ranges.

Space technology is an important and growing segment of the aviation industry market with close to $1 billion scheduled to be spent in military and civilian space exploration projects during the next fiscal year. These new projects that will be reaching the experimental hardware stage during the next few years will include the Sentry and Discoverer military communications, reconnaissance and weather satellites; the man-in-space Project Mercury; the USAF-NASA Scout research rocket program and probes toward the moon, Mars and Venus.

Superior coverage of top new European technical developments continued under the direction of David Anderton, Aviation Week's European editor with headquarters in Geneva, Switzerland. Aviation Week's West Coast bureau under the direction of Irving Stone expanded to five full-time editorial specialists to provide on-the-spot coverage of this key area in aircraft missiles and space technology.

In addition, Aviation Week's editorial staff of 32 graduate engineering and aviation specialists traveled through Europe, Asia and South America on USAF, Navy and airline trips to provide on-the-spot coverage of major aviation events such as the International Transport Assn.'s general meeting and fare conferences, the Society of British Aircraft Constructors annual flying display, the changing NATO aviation and missile pattern and the expanding pattern of international airline jet operations.

Advertising Leadership

For the tenth consecutive year, Aviation Week led its field in total volume of advertising published. Under the direction of E. P. Blanchard, Jr., advertising sales manager, Aviation Week published 3,779 pages of advertising in 1958. This was 1,687 pages more than its closest competitor and represented 50% of the total advertising volume carried by the top three publications in this field. Once again, Aviation Week was among the top 10 industry publications rated according to advertising volume. Aviation Week's closest competitor was rated 40th in this national compilation.

Aviation Week's outstanding editorial coverage of missile developments, and space technology, in addition to its other features, attracted more than 100 new advertising schedules during the past six months, largely in the space technology field.

For January, 1959, Aviation Week showed an increase of 40 pages over its advertising volume for the same month of last year, the largest gain of any publication serving the aviation industry and its related technologies.

Circulation Increase

Demand for Aviation Week from the technical and management leaders of this industry boosted circulation to an all-time peak of 72,750 net paid subscribers by the end of January. Aviation Week's net paid circulation for the six months ending Dec. 31, 1958, as filed with the Audit Bureau of Circulation and subject to audit, was 71,950. Under the direction of circulation manager T. J. Lucey, Aviation Week's circulation will climb past 75,000 in 1959. Aviation Week is a member of the Audit Bureau of Circulation with a subscription price of $7 per year. New and improved methods of speeding delivery of Aviation Week to its world-wide circulation are planned for 1959.

A total business volume of over $14 billion is in prospect for the aviation industry and its related technologies in 1959. However, this continued high level of business activity will also face the industry with major competitive, political, technical and economic problems.

Aviation Week will continue to report the activities of this industry—its technical progress and its political and economic problems—as a strong, independent voice with accuracy as its guiding principle.

—Robert W. Martin, Jr.

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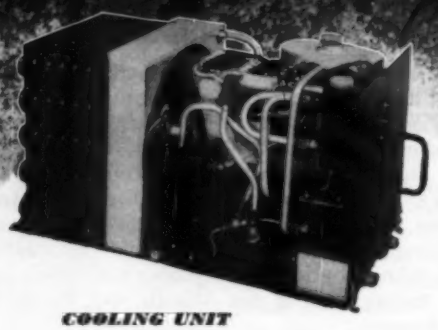

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WHO'S WHERE

In the Front Office

Strato-Safety Manufacturing Corp., Torrence, Calif., a newly organized subsidiary of The Dayton Rubber Co., Dayton, Ohio, has appointed the following officers: **Clowes M. Christie**, president; **Edward M. Rothermel**, executive vice president and general manager; **Glenn E. Mallory**, secretary-treasurer.

Sidney A. Stewart, president, Chandler-Evans Corp., West Hartford, Conn. Also: **Alexander M. Wright**, vice president-engineering; **Thomas Linder, Jr.**, vice president-manufacturing; **Louis G. Burns**, vice president-sales.

Earl L. Fester, president, and **Davis Spencer**, vice president, M-D Blowers, Inc., Racine, Wis.

R. L. Dickson, executive vice president, Walter Kidde & Company, Inc., Belleville, N. J.

J. Gordon Bennett, Special Assistant to the Administrator, Federal Aviation Agency, Washington, D. C. Also: **Brig. Gen. George S. Cassaday**, Deputy Director, FAA's Bureau of Air Traffic Management.

Lynn D. Richardson, vice president-sales, Solar Aircraft Co., San Diego, Calif.

James A. Sneller, vice president in charge of operations for Wyle Manufacturing Corp.'s new Mantec Division, El Segundo, Calif.

English Electric Aviation Co., newly formed subsidiary of English Electric Co., London, England, has appointed **H. G. Nelson**, chairman and managing director, and **Lord Caldecote**, deputy managing director. The board also includes: **Sir George Nelson; Sir John Woods; Sir Conrad Collier** and **F. W. Page.**

Honors and Elections

Ira G. Ross, president of Cornell Aeronautical Laboratory, Inc., has been appointed chairman of the new Research Division of the American Ordnance Assn.; **Dr. Wilmer L. Barrow**, vice president-research and development of Sperry Gyroscope Co., has been appointed chairman of the AOA's Fire Control Instrument Division.

J. L. Atwood, president of North American Aviation, Inc., has been elected to the board of the National Industrial Conference Board.

Dr. George R. Arthur, manager of design engineering for the Airborne Systems Department of Defense Electronic Products of Radio Corporation of America, has been elected president of the American Astronautical Society.

James R. Kerr, vice president of Avco Manufacturing Corp. and president of both the Lycoming Division and the Research and Advanced Development Division, has been elected the 1959 Chairman of the Aircraft Industries Assn.'s Utility Airplane Council. Mr. Kerr succeeds William T. Piper, president of Piper Aircraft Corp.

Dr. William H. Pickering, Director of the California Institute of Technology's Jet Propulsion Laboratory, has been presented the 1958 Award of the Institute of Radio Engineers' Professional Group on Reliability and Quality Control.

(*Continued on page 109*)

INDUSTRY OBSERVER

► Animals will be fired over short ballistic trajectories in capsules boosted by both Redstone and Jupiter missiles as a preliminary part of the Project Mercury man-in-space program. Army Ballistic Missile Agency personnel under Dr. Wernher von Braun will provide the boosters and launch teams. National Aeronautics and Space Administration's Langley Research Center probably will construct the capsules. Launchings will be made along the Atlantic Missile Range. If animal shots are successful, manned capsules are expected to be fired along the same less-than-orbital trajectories. These tests will precede manned flights in the more complex Mercury capsules to be built by McDonnell Aircraft Corp. under its recent contract award (AW Jan. 19, p. 30).

► Diversey Engineering Co. was subcontractor for the beryllium heat sink in six of the 12 man-in-space capsule proposals submitted to National Aeronautics and Space Administration in the Project Mercury competition including the winning bid submitted by McDonnell Aircraft Corp.

► Watch for Air Force to program an engine retrofit for its Boeing B-52 bomber fleet with Pratt & Whitney JT3D-1 turbofan engines. Retrofit would utilize about 75% of the J57 engine components now used on the B-52 with addition of 25% new parts. Use of turbofan engine (see page 48 for technical details) would increase the combat radius of the B-52 more than 10% over current capability and provide a 50% increase in takeoff power.

► Bell Aircraft and Thompson Ramo Wooldridge Corp. will work as a team to bid on Air Force's upcoming air-launch intermedite range ballistic missile (AW Dec. 22, 1958, p. 22), with Bell Aircraft as prime and Thompson Ramo Wooldridge serving as avionic subsystems manager. McDonnell Aircraft, which participated in Air Force feasibility study program along with Martin and a Convair-Lockheed team, also is expected to bid for the IRBM.

► First static firing for an engine for the Army-Martin Pershing solid-propellant 500-700 mi. missile already has taken place. Pershing can be moved by helicopter, is designed to be tactically transportable by air.

► Juno V is designation for the 1.5-million-lb. thrust rocket vehicle being developed by Army Ballistic Missile Agency for Advanced Research Projects Agency. Juno V uses eight 150,000-lb. thrust Rocketdyne engines. Four are clustered in the center of a circle. Four more are positioned 90 deg. apart around the circumference of the circle. Each of the outer four is free to move in one plane, to provide directional and pitch control.

► Jupiter intermediate range missile's guidance package, which travels with the nose cone for a time after the booster separates, has four attitude control jets plus a spin rocket designed to give the vehicle a slow rotation so that ablation of the nose cone will be uniform. Non-uniform ablation might change the aerodynamic stability and cause the cone to "dish out" and fly off course.

► Air Force will soon call for industry bids on a new Electronic Intelligence and Communications Intelligence Supporting System identified as 466-L. Rome Air Development Center will sponsor the program aimed at integration of Air Force's electronic countermeasures reconnaissance activities.

► Army decision on choice of contractor to develop its new Mauler truck-transportable tactical missile is expected soon, probably in February.

► Navy Bureau of Aeronautics is considering possibility of using an inertial system for mid-course guidance of its new Eagle air-to-air missile and may launch such a development program as a back-up to presently planned radio-control mid-course guidance. Terminal guidance is a Doppler radar developed by Sanders Associates.

► Titan ICBM under current Air Force plans, would be used against targets that are buried or otherwise well protected. Minuteman ICBM is designed for more exposed targets.

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Tactical and maintenance training techniques are now enhanced by combining dynamic problems and tactical situations using a complex Simulator Test Set developed and in production at Stavid. Operational submarine-based missile crews are now being trained in system check-out procedures and guidance techniques under true operating conditions... but without firing a missile!

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Washington Roundup

Budget Reaction

Reaction to President Eisenhower's hold-the-line Fiscal 1960 budget (see page 30) generally followed partisan lines—the Republicans defending it, the Democrats criticizing. Democratic members of both the Senate and House expressed doubt that $40.9 billion estimate for defense and funds asked for research and development are sufficient to protect the national interest. Examples:

Rep. Overton Brooks (D.-La.), new chairman of the House Space Committee, said research and development spending should be boosted $1.5 billion over the $5.5 requested by the Administration. Brooks added that funds asked by the Administration for this purpose were inadequate to meet the Soviet challenge in space and other broad fields of science.

Sen. Henry M. Jackson (D.-Wash.) said the budget fails to recognize the importance of being first in the achievement of vital weapon systems.

Speaker of the House Sam Rayburn said Congress will provide whatever amount is necessary for national defense after that need has been developed by the Appropriations Committee.

On the other hand, Rep. Charles A. Halleck (R.-Ind.), House minority leader, said the budget as it stands will provide a strong defense, provide progress in meeting human needs and stimulate a prosperous and expanding economy.

Sen. Thomas H. Kuchel (R.-Calif.) said the budget lays down a spending formula for defense, continuing progress in outer space and for missile development which deserves honest and fair legislative consideration.

Who's Ahead

Meanwhile, hearings "to straighten out the confusion over the nation's defense and space programs" and determine "who's on first?" will start this week, according to Sen. Lyndon Johnson (D.-Tex.). The investigation is being made jointly by the Armed Services Preparedness Subcommittee and the Senate Space Committee. Johnson heads both groups.

Two themes of the hearings, Johnson said, will be: "Is the U.S. doing everything it reasonably can and should (1) to ensure the defense of this country and the free world against military aggression, and (2) in the exploration of outer space?"

Transport Probe

Senate Commerce Committee is moving forward with a comprehensive investigation to determine what government policies and practices should be toward the various transportation systems. The resolution authorizing the review, introduced last week by Sen. Warren Magnuson (D.-Wash.), committee chairman, specifies these subjects:

- "**The need for regulation of transportation** under present-day conditions and, if there is need for regulation, the type and character of that regulation.
- "**Federal policy dealing with government** assistance provided the various forms of transportation and the desirability of a system of user charges to be assessed against those using (government-financed) facilities.
- "**Ownership of one form of transportation** by another.
- "**Policy on consolidations and mergers. . . .**"

New Democratic members on the committee this year are Vance Hartke (Ind.); E. L. Bartlett (Alaska); Gale McGee (Wyo.); and Clair Engle (Calif.). New Republicans are: Clifford Case (N. J.); Thrustan Morton (Ky.); Hugh Scott (Pa.).

Soviet Goals

Soviet leaders see the possibility of dominating the world through scientific achievement rather than through military conquest, according to Dr. Alan T. Waterman, director of the National Science Foundation. During his annual report of the foundation's activities, Waterman also stated that Soviet Russia is benefiting from "a determination and a national spirit on the part of the people which seems to be relatively absent from the American scene." Waterman further warned that the U. S. would rapidly lose in the technical competition with the Soviets unless we show more constructive and determined efforts than have been shown during the last few years.

Waterman also feels that the Soviets see their way clear in achieving world leadership in science and technology.

Scientist Exchange

Final agreement appears near between the Academies of Science of the U. S. and the USSR on a large-scale exchange of scientists to participate in meetings, give lectures and, in some cases, to cooperate in laboratory work. About 100 Russian and a like number of U. S. scientists will take part in the program for periods ranging from a few months to a full year. This exchange of scientists is part of the Lacy-Zaroubin agreement reached last year with the purpose of improving cultural relations between the nations.

Excess Buying

General Accounting Office has charged Rome Air Force Depot, Rome, N. Y., with wasting funds by overbuying ground communication-electronic equipment—a $500 million-a-year program—and failing to make prompt cancellations. Excesses pointed out to USAF by GAO investigators resulted in contract cancellations of $1.4 million. GAO added: "The Air Force responded very favorably to our findings and recommendations and stated that extensive improvements have been made in the management system."

Tourist Aid

Charles S. Thomas, president of Trans World Airlines, has promised to talk to the State Department about establishing government tourist offices in the U. S. to help foreign travelers have a vacation in this country on the limited amounts their governments permit them to take out of the country. In London, Thomas told Britons they could have very fine vacations in America on the $280 the British government allows its citizens to take out of England for holiday pleasures. Thomas indicated the amount was ample "provided one knowns where to go."

He said the U.S. government is doing very little to lure British tourists to the U. S. and that he plans to urge the State Department to take steps that will correct this deficiency.

—Washington staff

Soviets Hoped to Impact Mechta on Moon

Three-stage vehicle designated CH-10 had initial 660,000 lb. thrust; 13 stations tracked flight.

Bonn—Soviet lunar rocket Mechta (AW Jan. 12, p. 26) was launched at 10 a.m. Greenwich Mean Time on Jan. 2 by a three-stage, 104.9-ft. vehicle and was intended to impact on the moon at a point roughly along its equator, rather than to miss the moon by 2,187 mi. as the Russians now say it did.

Launching vehicle, which carries the designation CH-10, had a gross weight of 352,000-lb., an initial thrust of 660,000 lb., and was similar to those used to launch the three Soviet Sputniks.

Documented reports from the USSR, including projected flight paths, make it clear that the rocket's target was the moon.

The rocket was launched from a point at 47 deg. N. latitude and 62½ deg. E. longitude, slightly to the northeast of the Aral Sea on the border of European Russia. Thirteen tracking stations sweeping from Prague, Czechoslovakia, to Voroshilov near the Pacific Ocean followed the rocket as it headed first south, then turned in an easterly direction. Angle of injection was 71 deg. from the vertical.

A guidance system utilizing a perforated programming strip in the vehicle for coarse control and a ground-based radar directional beam for precise control permitted the Russians to come within 3 deg. of their target. Key to the Soviet success was ability to cut off third-stage burning with 0.1 sec. accuracy when the rocket had achieved escape velocity of 6.98 mi./sec. on preordained path. Soviets sent entire 3,245.76-lb. third stage rocket containing guidance and payload into space, following pattern of Sputnik III launching.

Top priority was given to elimination of non-essentials. No provision was made for destruction in flight.

Four transmitters relayed scientific information to earth. A fifth transmitter was installed as a standby in the event the other four failed. For the first time, all electronic equipment in the rocket was fully transistorized and printed circuits were incorporated. Much of the high purity germanium required came from Communist China.

Additional indication that Mechta was aimed for a direct moon strike is the apparent absence of any vernier rockets.

CH-10 launching vehicle consists of a first stage, which is a modified T-3A ICBM; a second stage, a modified T-2 IRBM, and a third stage specifically designed for space flight. In contrast with Sputnik launchings, Mechta first stage was supplemented by two solid fueled Golem 3s to ensure that escape velocity would be reached. Golem rockets are employed militarily as underwater-to-air or as surface-to-air missiles.

An exotic fuel consisting of hydrocarbon with boron additive was used with liquid oxygen in a ratio of 2.4:1 for all three stages.

Unexpectedly strong magnetic fields prior to third stage cut-off helped prevent the Soviets from hitting the moon, but the near-miss confirms functioning of all systems within tolerable limits. Release of five-gram sodium cloud by a preset timer provided the first independent check of CH-10 performance. Data from phototheodolite tracking was expected to be available about one week after launching. However, highly-detailed instrument readings sent in coded form from Mechta are expected to require about six months for evaluation.

Staging details include:

- **First stage:** Gross weight 184,800-lb. including 167,200 lb. of fuel; length 53.1 ft., diameter 13.7 ft., uniform throughout; thrust 484,000 lb. at sea level supplemented by 88,000-lb. thrust from each of two Golem engines for a total initial thrust of 660,000 lb. Golems were jettisoned at 6,600 ft. and thrust dropped to 484,000 lb. First stage liquid-fueled engine burned out at 80 sec., after increasing its thrust by 16% for a thrust at altitude of 562,000 lb. Burnout initiated ignition of second stage, but separation was delayed two and one-half sec. until second-stage engine was operating at full thrust. Separation of first stages was by explosive bolts. Speed of the vehicle after first stage burnout was 1:00 mi. sec.
- **Second stage:** Gross weight 113,300 lb. including 94,600 lb. of fuel; length 31.4 ft., diameter 13.7 ft., uniform throughout; thrust 410,000 lb. Burning time of second stage was 55 sec. by which time the vehicle had reached a velocity of 3.36 mi./sec. T-2 liquid propellant engine was highly modified to utilize exotic fuel in place of alcohol and liquid oxygen used in IRBM configuration. Third and final stage was ignited approximately two and one-half sec. before separation of second stage.
- **Third stage:** Gross weight 24,160 lb., including 20,900 lb. of fuel; length 20.3 ft.; diameter tapering from 5.3 ft. at base; thrust 99,000 lb. The stage contains a globular instrument package 24.5 in. in diameter weighing 797 lb. Burning time was 50 sec., at which point missile had been accelerated to a velocity of 6.98 mi./sec. necessary for vehicle and payload to escape from earth's gravitational pull. Total time for launch to third stage cutoff was 190 sec., including two separation periods of two and one-half sec. each during which the vehicle coasted until the next stage developed full thrust. In place of the black and white stripes

Nuclear Plane Budget

Washington—Atomic Energy Commission is asking Congress for $68.7 million for work on aircraft propulsion reactors in Fiscal 1960. This is $160,000 more than in Fiscal 1959. AEC also is asking $25.9 million for missile propulsion reactor work, up $3.035 million from Fiscal 1959; and $12.1 million for satellite power sources, an increase of $5.065 million.

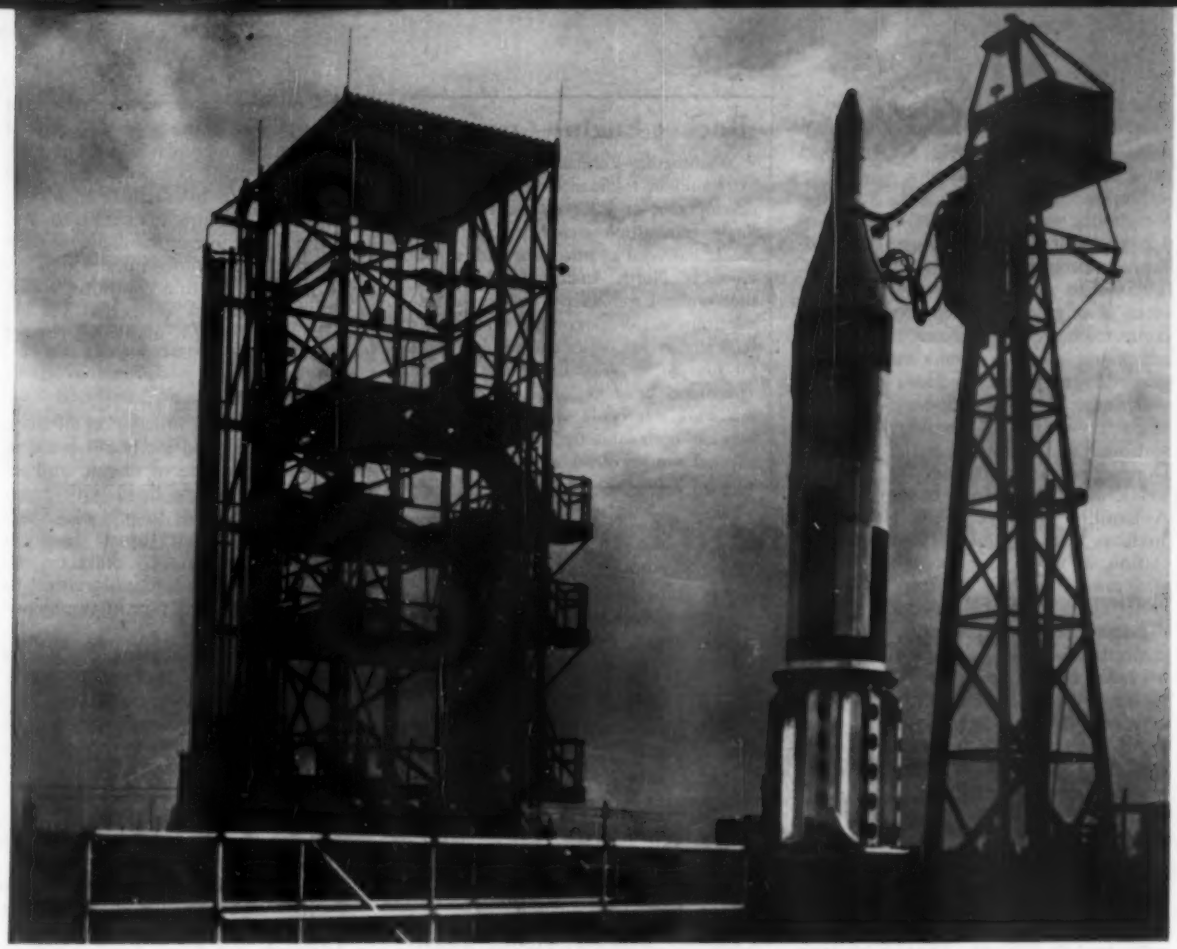
Undisclosed amounts for aircraft and missle nuclear propulsion also are contained in Air Force and National Aeronautics and Space Administration budgets. In his budget message to Congress, President Eisenhower said:

"Work will also continue, at about the same level as in 1959, on the development of a nuclear powerplant for military aircraft. Until such a powerplant is successfully developed, and the technical problems involved in operating a nuclear-powered aircraft safely are solved, there is no practical military value in attempting to build the airplane itself.

"It is the judgment of my scientific advisers, which I approve, that the pace of this program should continue to be geared to valid technical considerations."

B-70 Pod Bidders

Competition on an alert pod for the North American B-70 Mach 3 bomber has been narrowed to three bidders—Bendix, Temco and a Beech Aircraft—Thompson Ramo Wooldridge team with Beech acting as team leader. Alert pods will supply continuous power as well as extra power for starting purposes. Units probably will be built around a shaft turbine engine in the 1,000 hp. category (AW Nov. 3, p. 23).



Polaris Checked Out at Cape Canaveral

Ground checkout is under way on Lockheed Polaris fleet ballistic missile at Cape Canaveral, Fla. Note power cables connected to missile from umbilical tower at right. Access tower at left is moved onto launch pad on rails to allow technicians to work at various levels. Designed to be fired from under water, Polaris will be installed on submarine George Washington, first nuclear-powered submarine specifically designed for this mission (AW Jan. 19, p. 32).

used on US Pioneer III to control internal temperatures, Soviets painted one half of their instrument package white and the other half black.

Thrusts in second and third stages provided sufficient reserve power to spin the vehicle to 60 rpm, using the graphite guidance rudders to provide stability. In contrast, current U.S. practice is to use as many as eight vernier rockets to spin moon probes.

• **Launch:** The Soviets report that the launching took place "on time." Teams responsible for electronics, powerplant, fueling and airframe, as well as ground equipment handling crew were present in Bunker CL-57 near the launching pad at the time of the firing. Control headquarters were located at a precisely measured distance of one kilometer (3,280.84 ft.) from the pad. Interferometer checked the distance to five decimal-place accuracy between the vertical axis of rocket and vertical axis of Doppler tracker at main control station.

Firing procedure is described as follows: Sixty minutes prior to firing, electronic equipment in the main control station and in 12 subsidiary tracking stations with which it is linked by landline were switched on and checked. Ten minutes prior to firing, the procedure is repeated and alignment between subsidiary tracking stations and main control station is continuously maintained.

Rockets Checked

At the launching pad 60 min. before firing, all rocket instruments are checked. Fuel is checked and evaporation losses topped off. From 10 min. before firing, running checks are maintained on rocket instruments, on vertical positioning of rocket and on fuel tanks. At 10 sec. prior to firing, the nitrogen-driven gyroscopes in the rocket are started.

Fuel for engine run-up is piped in from an outside source, and a cartridge is fired to ignite the first-stage thrust chamber. At 5 sec. before launch, gyros must be at full speed, first stage turbine must be at full speed, rocket must be delivering full liquid-engine thrust of 484,000 lb.

If one of these three conditions is not fulfilled, launching will be prevented automatically. Between minus 10 sec. and minus 5 sec., firing can be scrubbed manually if any of crews in bunker detect a defect via instrument panels or visually. At minus 5 sec., with tanks full, gross weight is sent to a computer at the main control station. External fuel feed is cut out and, simultaneously, the feed from first stage tanks cut in. All three functions are automatically performed. At Time Zero, with conditions normal, the launch button ignites solid-fueled Golems and throws off retaining anchors, launching the vehicle.

Tracking is accomplished by one master and 12 other geographically separated stations, each outfitted with Doppler, radar and phototheodolite equipment. Data from these three methods are supplied to a computer, and the results fed to an IBM-type electronic computer. All three trackers are fixed

to a common tubular mounting that is movable about its vertical and horizontal axes. The entire system is supported on a concrete base.

Doppler is conventional, utilizing a parabolic reflector. Radar operates on 12 cm. wavelength, employing an antenna approximately 9.8 ft. in diameter. Theodolite uses Askania system, with some of original parts reportedly having come from West Germany where they are manufactured. Theodolite is worm-gear driven, protected from reflection and magnetically shielded.

Each of the 12 auxiliary tracking stations is equipped with identical Doppler-radar-phototheodolite trackers to the one at the master control station. A landline network ties each of the auxiliary tracking stations to the master station, as well.

Station Locations

Location of the 12 auxiliary tracking stations is as follows:

- **59 deg. 46 min. 18 sec. N.,** 30 deg. 19 min. 39 sec. E., near Poltava.
- **50 deg. 06 min. N.,** 14 deg. 17 min. E., near Prague.
- **47 deg. 29 min. 58 sec. N.,** 18 deg. 57 min. 52 sec. E., near Budapest.
- **55 deg. 12 min. N.,** 60 deg. 57 min. E., near Kischtim.
- **60 deg. 01 min. N.,** 30 deg. 05 min. E., near Sestroryczk.
- **64 deg. 15 min. N.,** 40 deg. 45 min. E., near Archangel.
- **56 deg. 08 min. N.,** 38 deg. 35 min. E., between Noginsk and Kirshatz in vicinity of Moscow.
- **55 deg. 00 min. N.,** 68 deg. 42 min. E., near Petropavlovsk.
- **50 deg. 48 min. N.,** 30 deg. 28 min. E., near Kiev.
- **51 deg. 18 min. N.,** 118 deg. 02 min. E., near Kavikutzi Gas.
- **43 deg. 16 min. N.,** 132 deg. 18 min. E., near Voroshilov.
- **Alma Ata Observatory.**

At 10 min. prior to firing, the main tracking station begins constant transmission of a sine wave signal to subsidiary stations. The sine wave establishes the norm for time, temperature, humidity, pressure and wind. Auxiliary stations correct to norm and are in phase when their locally generated sine wave is coincident with the sine wave transmitted from master station. Each auxiliary station is also equipped with program control card identical to the one at the main station, establishing ideal path of rocket.

After launch, each auxiliary station sends a signal to the master station indicating whether it has the rocket on beam. Information from the master tracker and all reporting auxiliaries is fed into the master computer, which provides a correcting time pulse if necessary. Correcting time pulse goes to beam timer, timer in missile and timers at auxiliary tracking stations. Correcting pulse to missile timer is sent as amplitude modulation of the antenna's beam.

Any subsidiary station that is not in phase with the main tracking station is automatically blocked from relaying information. Power supply for tracking stations is taken from a.c. net and converted to d.c. in order to power more precise d.c. driving motors.

Guidance and Control

Guidance and control equipment was physically located in the third stage of CH-10 and on the ground in the master control center, ½ mi. from the launching pad. The rocket can best be described as "time-guided." All controls were programmed, but additional ground-to-missile fine control was obtained by riding the vehicle on a beam projected by a parabolic antenna.

The ideal flight path was programmed on an aluminum-perforated card driven by an electronic quartz timer both housed in the rocket. A perforated card similar to the one inside the missile and carrying identical commands programmed the antenna's movement from the ground. Electronic timer in the rocket was pulse synchronized with an identical timer on the ground.

Guiding beam was powered by a 5,000 watt transmitter, crystal controlled on a 12 cm. wavelength. Antenna is 85.2 ft. in diameter. Signals to position beam guidance antenna were sent from a giant computer similar to the IBM-704 to hydraulic actuators.

Distortions of antenna's reflector surface due to temperature changes were measured by thermocouples which relayed information to a computer which made the necessary correction via hydraulic cylinder to maintain correct focus of antenna.

Fuel Systems

Thrust chambers utilized on all three stages were designed for non-hyperbolic exotic fuels. Nozzle of engine and its thrust chamber were lined with tungsten carbide. Similar to previous Sputnik vehicles, Mechta thrust chambers had a series of premix chambers arranged round their circumferences to ensure a perfect fuel mix in the chamber.

The Soviets claim that the inclusion of premix chambers in the design also enabled a higher pressure to be obtained in the thrust chamber, giving an exhaust velocity at altitude of 9,343 fps. to 10,000 fps. (compared with the maximum of 9,000 fps. reportedly obtained with the Vanguard chamber). Pressure of 350 psi. in the chamber dropped to 10 psi. at the nozzle tip. Higher pressure in the chamber and a temperature of 5,860F. made possible a fuel recombination process.

Although the flame temperature in the thrust chamber was in the range of 5,800F. twin cooling systems serving the chamber on the one hand and the nozzle throat and nozzle proper on the other hand combined to limit wall temperature to 1,112F. Instead of using liquid oxygen oxidizer as a cooling fluid, the Soviets used a portion of the fuel which was circulated by pump through jackets around thrust chamber and nozzle. Thermocouples scanning the chamber wall controlled the rate of coolant flow in relation to wall temper-

Rocket Engine Contract

Washington—Formal contract for $102 million to finance the design and development of a 1.5 million lb. thrust single combustion chamber liquid fuel rocket has been awarded Rocketdyne Division of North American Aviation by the National Aeronautics and Space Administration. Work covered by the contract already has begun and will continue for four to six years under the present agreement. Selection of Rocketdyne for this work was made in December after bids had been submitted in October by a selected number of engine manufacturers.

F-101B Stretchout

Washington—Production of McDonnell F-101B aircraft has been stretched out by the Air Force, reducing the previously-planned peak rate of 25 planes per month to 20 per month. McDonnell will lay off approximately 1,000 employes directly and indirectly engaged in F-101B production as a result of the stretchout. No reduction in Air Force orders is involved, and production under the new schedule will extend through December, 1960. Present McDonnell employment is 25,800.

Boutelle Resigns

Hagerstown, Md.—Richard S. Boutelle, who was named vice chairman of the Fairchild Engine & Airplane Corp. board of directors less than a month ago, resigned last week. No reason was given for his action.

F. E. Newbold, Jr., vice president-marketing and engineering, was elected to the board to fill the vacancy. Boutelle had served as vice president and general manager of Fairchild's Airplane Division from 1941 to 1949 and served as president of the company from 1949 to last December when he was elected vice chairman. At that time, he was replaced as president by James H. Carmichael, former president of Capital Airlines.

Mercury Rockets

Bristol, Pa.—National Aeronautics and Space Administration has awarded Thiokol Chemical Corp. a $2,383,173 contract for research, development and delivery of large, solid propellant rocket motors for NASA's man-in-space program Project Mercury.

An improved version of the XM33 which Thiokol developed for the first stage of the Polaris IRBM, the motor will be adapted for use as a booster for Project Mercury test vehicles. The motor will probably be used in clusters.

ature. Pumps also maintained fuel at critical pressure to prevent formation of air locks in fuel lines. After passing through the cooling system, the fuel was mixed with cold fuel in the tanks.

Fuel and liquid oxygen were injected in a ratio of 2.4 to 1 into premix chambers located around the upper half of the thrust chamber through individual injectors. Injection pressure varied between 1,918 and 2,556 psi. according to the amount of thrust required at the nozzle to keep the vehicle at its preset velocity. The amount of thrust required at any time during flight was determined by an integrator located in the missile third stage working in conjunction with the third induction coil of the stabilizing system. After mixing in the premix chambers, fuel was forced through a multi-jet nozzle located across the base of the premix chamber and into the thrust chamber proper.

All liquid oxygen and hydrocarbon injectors in the third stage were provided with magnetic needle valves actuated by a metallic contact strip positioned at the end of the perforated programming card. By stopping the flow of fuel by individual valves located directly in front of the injectors, the Soviets prevented a combustion 'popback' which might have thrown the last stage off course.

Fuel Supply Pumps

Fuel supply pumps used in all three stages of the vehicle were driven by steam turbines. Hot gas bled off from the side of the thrust chamber was fed to an expansion chamber where steam was generated at a pressure sufficient to drive the fuel pumps. In the initial stages of ignition when no surplus gas was available to drive the pumps, steam was generated by firing a heater cartridge in the turbine steam system. The cartridge was timed to remain burning until the vehicle engine was operating at full thrust and hot gas could be drawn off from the thrust chamber.

Transmitters started operating at 10 min. before zero time and were intercoupled with a magnetic trip system so that, should transmitter failure occur prior to burnout of last vehicle stage, fuel system would be cut off and vehicle leave its path. Reason for this was apparent unwillingness of Soviets to have Mechta traveling through space as a "silent" rocket.

Rocket's outer skin of chrome-plated steel was rolled onto duraluminum and electron (an aluminum-magnesium alloy with a trace of sodium) ribs and spars, then riveted into place. Transition sections between stages were made of heat-resistant chrome-molybdenum steel.

The Soviets have been extensively studying re-entry problems and may have made sufficient advance to be able to use modified Mechta configuration to bring a re-entry vehicle back to earth. Soviets have been experimenting with water jacket cooling (now believed to have been discarded due to excessive weight involved) and with simple wooden jackets. The latter method encloses the nose cone of the re-entry vehicle in a wooden jacket dimensioned to smoulder and burn away during the relatively short re-entry time, leaving the nose cone of the satellite reasonably cool.

Germans Begin Final Negotiation For F-104 Purchase, Licensing

Bonn, Germany—Final negotiations for purchase and license production of Lockheed F-104 series Starfighters by West Germany started here last week.

Talks are continuing between the two American manufacturers directly involved—Lockheed Aircraft Corp., and General Electric Co., manufacturer of the planes' J79 turbojet engine—and the Federal Republic's Defense Department, actual license holder.

Hopes are that the contracts will be signed by the end of this month.

Germany's major objective is rebuilding its aircraft industry by injecting a healthy production order. Consequently a prime question remaining in negotiations is the proportion of purchased engine-airframe combinations to those manufactured under license. Both American companies have been asked to submit a range of proposals starting with low quantity purchase and high quantity production and varying by blocks of airframe-engine combinations to exactly the opposite.

So far there has been no firm commitment on the number of complete Starfighters to be bought. During the long buildup that preceded these final negotiations, various German sources indicated numbers between a handful and the entire order of probably 300. But AVIATION WEEK has learned that current proposals favor the outright purchase of 50 or more fully-equipped ready-to-fight airplanes for delivery early in 1960. The remainder would be built under license.

One startling development is that about half of this purchased batch is reported to be two-seater all-weather versions of the Starfighter (AW Jan. 19, p. 35) slated for the German Navy.

Whether the Starfighters are intended as replacement equipment or additional strength is not known, but the latter seems more likely.

Because of the difference in lead time between engines and airframes, informed observers believe that the initial order for the General Electric J79 turbojets will be for a quantity considerably higher than the number of purchased airframes. Current estimates are that the remainder will probably be built by Bayerische Motoren Werke (BMW) under license.

Quantities ordered will depend on cost balances of the proposals made by General Electric and Lockheed. License fees will vary depending on the number of units purchased from each company. Against these fees must be balanced the economics of home production by an untrained German industry just beginning to feel its growth.

Strongest opposition to large-scale tooling and license production comes from German government economists. They feel the F-104 could be a one-shot order with no repeats.

French-German Transport

Bonn—Compromise has been reached between French and German proposals for a medium attack transport for equipping the air forces of both countries. The transport is to have a maximum gross weight of 99,000 lb. and a payload of 17,600 lb. A prototype has been requested within two years.

Final design, which must be approved by the air subcommittee of the French-Italian-German armaments pool, will be based on two French and two German proposals. French proposals are by Breguet and Nord Aviation. German ones are from Hamburger Flugzeugbau and Weser Flugzeugbau. Group of French and a group of German companies will produce the airplane.

Transport agreement is first major joint project to be arrived at since three-cornered armaments pool between Bonn-Paris-Rome was established at the beginning of last year.

Budget Holds Spending to Current Level

By Evert Clark

Washington—Eisenhower Administration last week asked for a balanced budget for Fiscal 1960 that would hold defense spending at about the current $41 billion level. Congressional criticism already has indicated, however, that there will be some upward revisions.

In sending his $76.8 billion national budget request to Congress, President Eisenhower said "this budget assures that essential defense needs are met."

Aircraft inventories continue to decrease under the budget. Missile spending, slightly increased, will buy a higher percentage of operational hardware as some missile systems move out of the development and test area and other systems are canceled.

New aircraft procured will total 1,610—with 703 going to Air Force, 688 to Navy and 239 to Army. This is about 150 fewer planes than are being procured in Fiscal 1959.

For the first time this year, Defense Department has shifted some aircraft and missile development and test funds out of procurement accounts and added them to the old research and development accounts, creating a new budget category called "research, development, test and evaluation."

Because of this change, comparisons with previous years are made most accurately by adding the new procurement and research categories together. These totals show that Defense Department will obligate $868 million less in new money for developing and buying aircraft and missiles than it did in Fiscal 1959 and will pay out $119 million more in these areas than it did in Fiscal 1959.

Figures in the accompanying table of major expenditures and obligations for the three armed services (see p. 31) do not reflect the change in accounting. They are presented on the old basis so that three-year comparisons may be made.

Defense is requesting $41.190 billion in new funds for Fiscal 1960. This includes $340 million to be transferred from 1959. To this will be added $700 million which Congress gave the Department last year over and above the Administration's request but which Defense did not spend. Effective figure for new obligational authority is therefore $41.890 billion.

Spending Estimate

Defense expects to spend $40.945 billion in Fiscal 1960. Of this, $6.265 billion will go for procurement of aircraft and $3.825 billion for procurement of missiles. Another $3.384 billion will be spent for research, development, test and evaluation.

Defense expects to obligate $6.197 billion for aircraft, $3.548 billion for missiles and $3.772 billion in the research and test category.

Operations and maintenance for the Department will run at approximately the same $10 billion that is required for Fiscal 1959.

The President asked for extension of the tax on corporation profits for another year and an indefinite extension of the Renegotiation Act.

Air Force portion of the new obligational authority requested for 1960 is $18.682 billion, down $135 million from last year. Navy's share is $11.370 billion, a decrease of $428 million; Army's share is $9.357 billion, an increase of $14 million. Transfers would give Army an additional $200 million, Navy $90 million and USAF $50 million.

Air Force expects to pay out $18.675 billion, or $318 million less than last year; Navy expects to spend $11.596 billion, or $124 million more than last year; and Army expects to spend $9.264 billion, or $99 million more than last year.

Office of Secretary of Defense, which includes the Advanced Research Projects Agency appropriation, is asking for $1.441 billion in new funds, an increase of $162 million. It expects to spend $1.410 billion, an increase of $240 million.

ARPA itself is asking for $455 million in new obligational authority. Congress last year gave ARPA $520 million, but this was adjusted to $399,742,000 after civilian space projects were transferred to National Aeronautics and Space Administration.

ARPA's budget calls for new authority to contract for $307 million in military astronautics and related equipment, $128.1 million for missiles and related equipment, and $18 million for military sciences. Expenditure figures are not available but will be in approximately the same ratio as obligations—about 68% for astronautics and about 28% for missiles.

The following figures for aircraft and missile procurement and research, development, test and evaluation in the three services are taken from the new method of accounting. This means that funds previously listed in procurement accounts but used to support research and development work have begun to be transferred into the research account.

New Money Requests

This process is not yet complete, however. USAF's test models of the B-58 Hustler, for example, are still listed under procurement. Army is farthest along in transferring, Navy is next and USAF "still has some things in procurement that may after further consideration be transferred," according to Defense fiscal officials. Here are the figures:

- **USAF is asking $4.409 billion** in new money for aircraft and $2.601 billion for missiles. It expects to spend $4.362 billion for aircraft and $2.768 billion for missiles. It is asking $1.150 for research, development, test and evaluation, and expects to spend $1.011 billion in this category.
- **Navy is asking $1.725 billion** for aircraft and $645 million for missiles. It expects to spend $1.778 billion for aircraft and $593 million for missiles. Re-

Airpower Program

	Actual: End FY 1957	End FY 1958	Planned: End FY 1959	End FY 1960
Air Force				
Wings	137	117	105	102*
Active Aircraft Inventory	25,969	22,578	20,358	19,982
Navy				
Carrier Air Groups	17	17	16	16
Carrier Antisubmarine Squadrons	20	22	22	22
Patrol and Warning Squadrons	..	39	39	42
Marine Air Wings	3	3	3	3
Active Aircraft Inventory	11,617	10,533	9,300	9,200
Army				
Antiaircraft Missile Battalions	..	65	71	73½
Active Aircraft Inventory	4,447	5,027	5,289	5,363**

* Strategic 43; Air Defense 25; Tactical 34.
** Includes 2,558 Helicopters.

Major Expenditures and Obligations

(IN MILLIONS)

	N. O. A.* FY 1958	Expend. FY 1958 (actual)	N. O. A. FY 1959*	Expend. FY 1959 (est.)	N. O. A. FY 1960	Expend. FY 1960 (est.)
Air Force						
Aircraft	4,190	6,084	4,333	3,030	4,558	4,669
Missiles	1,890	1,668	2,938	2,356	2,624	2,661
Electronics & Communications	552	537	803	346	940	573
Production Equipment & Facilities	300	251	120	227	108	151
Research & Development	750	694	740	755	750	725
Operation & Maintenance	4,019	3,788	4,123	4,213	4,274	4,191
Navy						
Aircraft	1,536	2,287	1,680	1,972	1,725	1,778
Missiles	402	345	735	417	703	566
Electronics & Communications	144	143	181	175	308	233
Production Equipment & Facilities	32	80	35	88	40	73
Research & Development	573	569	831	716	783	779
Operation & Maintenance	2,537	2,494	2,544	2,583	2,645	2,605
Army						
Aircraft	.....	157	130	115	70	143
Missiles	20	724	672	587	634	695
Electronics & Communications	.....	198	237	215	203	231
Production Equipment & Facilities	.....	123	136	36	117	49
Research & Development	506	476	532	519	573	547
Operation & Maintenance	2,813	2,831	2,770	2,774	2,714	2,746

*New obligational availability.
*Includes proposed supplemental requests.

Note: Defense Department has regrouped its appropriations by titles rather than by services, but Aviation Week is continuing to list by services so that direct comparison with previous years can be made.

search and development request is $971 million, and expenditures for this will be $922 million.

• **Army is asking $63 million** for aircraft and $302 million for missiles, and expects to spend $126 million for aircraft and $463 million for missiles. Research and development request is $1.047 billion and research expenditures are $909 million.

USAF loses two air defense and one tactical wing, dropping from a total of 105 combat wings to 102 (see table p. 30).

Reasons cited for the air defense cuts are entry of more Century Series fighters into the inventory, more and better air-to-air missiles and appearance of the Boeing Bomarc interceptor missiles.

Average active duty personnel is expected to stand at 848,607 by the end of Fiscal 1960.

Active aircraft inventory, including support squadrons, will stand at 19,982, a reduction of 376 aircraft from the end of Fiscal 1959. MATS squadrons will decrease from 27 to 24 but over-all ton-mile capacity will increase.

Air Force Program

USAF program in Fiscal 1960 will include:

• **"Considerably higher" procurement** of Boeing B-52 bombers, Convair B-58 bombers and Boeing KC-135 tankers than in 1959. By the end of Fiscal 1959, all 11 heavy bomber wings will have been converted from 30 Convair B-36s to 45 B-52s each. Portion of a 12th wing also will be operational. By the end of Fiscal 1960, first full squadron of B-58s will have been phased into Strategic Air Command.

• **No procurement of interceptors** and fewer fighter-bombers. All-weather Republic F-105 will be procured. Program has moved more slowly than expected in Fiscal 1959.

• **Activation of the first wing** of strategic missiles.

• **Very little new money for** the Douglas Thor and Chrysler Jupiter intermediate range ballistic missiles. If more NATO countries accept these missiles, they will be bought from military assistance funds. Any to be used as space boosters would be bought by ARPA or NASA.

• **Continued support of the** "accelerated" Atlas intercontinental ballistic missile program, which will become operational in Fiscal 1959, plus a 50% increase in the Martin Titan ICBM program and a 40% increase in the Minuteman ICBM. These percentages include construction money and do not mean 50 and 40% increases in development effort only.

• **Continued development of the** North American B-70 bomber and F-108 interceptor, and continued development of Dyna-Soar.

• **Substantial increase in electronics** and communications equipment, much of it for air defense. SAGE and the ballistic missile early warning system account for one-third of the electronics and communications procurement funds, not counting avionics in aircraft and missiles.

• **Accelerated production of** the North American Hound Dog air-to-surface missile for the B-52G.

• **Continued procurement of the** Martin Mace and procurement of an improved model of Bomarc.

• **Increased requirements for target** and drone missiles for testing aircraft and missiles and training crews.

• **Development of an** "advanced air-to-air missile for air defense."

USAF aircraft and missile funds break down this way:

• **Aircraft procurement and** production —$2.909 billion; ground support equipment, $144.2 million; development, test and evaluation support, $515 million.

• **Missile procurement and** production —$1.092 billion; ground support equipment, $535.1 million; development, etc., $777.5 million.

Navy Program

U.S. Navy Program in Fiscal 1960 will include:

• **668 new aircraft,** bringing the active inventory to 9,200, a drop of 100 from last year (table, p. 30). Inventory by the end of 1960 will include 600 anti-submarine warfare aircraft. Procurement will include Douglas A4Ds, Grumman A2Fs, North American A3Js, Chance Vought F8Us, McDonnell F4Hs and improved patrol and search aircraft.

• **Two new anti-submarine** warfare task forces.

• **18 new warships and 13 conversions.** New ships include one Forrestal-type carrier, six guided missile destroyers and frigates and three nuclear attack submarines.

• **Advanced procurement for** long-lead time items for three more Polaris fleet ballistic missile submarines. A second submarine tender also is included.

• **Continued development of** the Lockheed Polaris fleet ballistic missile. Of the $609 million that Congress gave Defense for Polaris above Administration requests, only $308.7 million is being spent in Fiscal 1959—for one submarine, one tender, and $71 million for research. The remainder will be added to 1960 Polaris funds.

• **Continued procurement of Convair** Terrier and Tartar and Bendix Talos ship-to-air missiles and Philco Sidewinder air-to-air missiles. Raytheon Sparrow III air-to-air and Martin Bullpup air-to-surface missiles will become operational.

• **Continued development of** Bendix Eagle air-to-air and Temco Corvus air-to-surface missile.

• **Marine Corps procurement** of Army-Raytheon Hawk surface-to-air missile.

• **Procurement of submarine-,** surface-,

and air-launched torpedoes and Asroc anti-submarine weapon.

• **Accelerated construction on** the Pacific Missile Range.

Army's program for Fiscal 1960 includes:

• **70 Western Electric** Nike-Ajax and Nike-Hercules battalions to be operational by the end of 1960.

• **Inventory of 5,363 aircraft,** an increase of 74 from the end of 1959. This includes procurement of 239 new aircraft. Inventory will include 2,558 helicopters and 2,805 fixed wing.

• **73¾ guided missile battalions** and three heavy field artillery missile groups.

• **Martin Pershing** 500-750 mi. solid-fuel ballistic missile will continue in development, and may go into the procurement category, taking advantage of the phasing out of Redstone, for which there is no 1960 money.

• **Continued development** of Western Electric Nike-Zeus anti-missile missile.

• **Procurement of the Grumman** Mohawk observation aircraft.

Space Technology

$485 Million Asked for NASA

By Ford Eastman

Washington – President Eisenhower last week proposed a $485.3 million budget to carry out programs of the new National Aeronautics and Space Administration for Fiscal 1960. He also plans to ask for $48.3 million in supplemental funds for Fiscal 1959.

The Fiscal 1960 estimate is $183.2 million more than the funds now available for Fiscal 1959 and about $135 million more than the current year when the proposed supplemental is included.

Part of the Fiscal 1959 funds were provided solely for the National Advisory Committee for Aeronautics, which formed the nucleus of NASA when it came into existence on Oct. 1. The remainder was made available through appropriations and transfers after the agency's activiation. The total, including the proposed supplemental, will amount to $350.4 million for the current year.

The supplemental will include $3.354 million for salaries and expenses, $20.750 million for research and development and $24.250 million for construction and equipment.

In his budget message to Congress, the President said these funds will be used to provide tracking and control equipment at various locations in support of scientific and developmental space vehicle operations; space propulsion system development facilities, and facilities for the Jet Propulsion Laboratory at Pasadena, Calif. The research and development portion of these funds will be used exclusively for contracts related to the program for developing the technology of manned space flight.

Estimates for Fiscal 1960, which first must receive special authorization from Congress, will be broken down this way: salaries and expenses, $94.4 million; research and development, $333 million; construction and equipment, $57.8 million.

The 1960 estimates for salaries and expenses actually come to $111.1 million, but procurement of supplies and minor equipment for the various research centers, amounting to $16.6 million, will be funded under the $333 million research and development appropriation.

The $94.4 million balance for salaries and expenses represents a $7.9 million increase over the current fiscal year including the supplemental, and provides an increase in the total number of employes from 8,951 to 9,988.

Research and development estimates for 1960 are $141.3 million above those of Fiscal 1959 with the supplemental included, but the next fiscal year's construction and equipment estimates are $14.4 million below the current year.

A breakdown of the 1960 construction and equipment and salaries and expenses budgets by stations:

• **NASA headquarters** in Washington, $6.4 million for salaries and expenses, an increase of $1.5 million over the current year. No funds were sought for construction and equipment.

• **Langley Research Center,** Hampton, Va., $32.7 million for salaries and expenses, an increase of $2 million, and $4.5 million for construction. Projects include thermal structures tunnel alterations, $745 thousand; analytical computing equipment, $2.6 million; conversion of gust tunnel to noise research laboratory, $315,000; conversion of test cell to noise test facility, $290,000, and heater and vacuum system for Gas Dynamics Laboratory, $585,000.

• **Ames Research Center,** Moffett Field, Calif., $18.3 million for salaries and expenses, an increase of $1.8 million and $6.5 million for construction and equipment. Projects include: Data reduction center, $2.5 million; mass transfer cooling and aerodynamic facility, $4 million.

• **Lewis Research Center,** Cleveland, Ohio, $31.7 million for salaries and expenses, an increase of $4.1 million, and $6.8 million for construction and equipment. The projects include ion and plasma jet facility, $6 million; zero-power reactor, $605,000; in-pile loop, $225,000, and land acquisition, $5,000.

• **High-Speed Flight Station,** Edwards AFB, Calif., $3.3 million for salaries and expenses, an increase of $520,900,

National Aeronautics and Space Administration
Research and Development Programs

Fiscal 1959 and 1960

Program	FY '59	FY '60
	(in millions of dollars)	
Aircraft, Missile and Spacecraft Research (support of NASA plant, JPL plant, and research contracts)	$ 13.995	$ 33.026
Scientific Investigations in Space (sounding rockets, earth satellites, lunar probes, deep space probes, Vanguard program)	110.563	118.344
Satellite Applications Investigations (meteorology, communications)	8.100	28.000
Space Operations Technology* (manned space flight, space rendezvous techniques)	37.661	73.000
Space Propulsion Technology (solid fuel rockets, high-energy fuel rockets, 1-million pound single-chamber engine, nuclear rocket engines, space engines, auxiliary power units)	29.000	64.200
Space Systems Technology (advanced vehicle systems, booster recovery systems, orbiting space laboratories)	1.000	5.000
Supporting Activities (tracking and data acquisition)	4.300	11.500
Total Program	$204.619	$333.070

* Supplemental estimate, FY 1959–$20.750.

National Aeronautics and Space Administration Appropriation Summary—Fiscal 1959 and 1960

	Fiscal 1959		Fiscal 1960
	Appropriated	Supplemental Estimates	Regular Estimates
Salaries and Expenses	$83,100,000	$3,354,000	$94,430,000
Research and Development	50,000,000	20,750,000	333,070,000
Construction and Equipment	48,000,000	24,250,000	57,800,000
Total Appropriations	$181,100,000	$48,354,000	$485,300,000
Transfers from Department of Defense	$154,619,532		
Air Force	$57,800,000		
ARPA	67,200,000[1]		
Navy (Vanguard)	25,541,282		
Army (JPL)	4,078,250[2]		
Total Obligational Authority	$355,719,532	$48,354,000	$485,300,000

[1] Includes $8,000,000 transfer in process.
[2] Transfer in process.

and $2.8 million for construction and equipment. Projects include: building additions, $995,000; analog computing equipment, $350,000, and terminal guidance facility, $1.5 million.

• **Space Projects Center,** Beltsville, Md., $14.7 million for salaries and expenses, an increase of $12.1 million over the estimated figure for 1959, and $14 million for construction and equipment. Projects planned for the new center are: central flight control and range operations buildings, $3.3 million; space sciences laboratory, $6 million; instrument construction and installation laboratory, $3.7 million; utility installations, $1 million.

• **Pilotless Aircraft Station,** Wallops Island, Va., $3.6 million for salaries and expenses, an increase of $2.3 million over the current year. No funds were asked for construction and equipment.

• **Patrick AFB,** Fla., facility, $55,250 for salaries and expenses, an increase of $27,850. No construction or equipment funds are involved.

• **Western Coordination Office,** Los Angeles, Calif., $80,000 for salaries and expenses, an increase of $30,395.

• **Wright-Patterson AFB,** Dayton, Ohio, $22,000 for salaries and expenses, an increase of $625.

• **Pacific Missile Range,** Point Arguello, Calif., $3 million for construction and equipment. Funds are for launching facilities, including a flight vehicle assembly and check-out facility with equipment for special experiments.

In addition, a total of $20 million is asked for construction and equipment at various locations. Projects include global range tracking and communication facilities and equipment, $10 million; facilities for the Rover nuclear rocket reactor program, $2 million; propulsion development facilities, $8 million.

Construction and equipment estimates in the Fiscal 1959 supplemental include $9 million for new facilities, improvements and acquisition of land for the Jet Propulsion Laboratory, Pasadena, Calif.; $12 million for global range tracking and communication facilities and equipment, and $3.2 million for facilities for the Rover program.

SenateGroupApproves USAF Fund Transfer

Washington—Transfer of $13 million in Air Force fiscal funds to facilitate production of "a more advanced" weapon system was approved last week by the Senate Defense Appropriations Subcommittee.

Sen. Dennis Chavez (D.-N.M.), subcommittee chairman, said the funds had been appropriated for other programs but that more advanced weapons would reach the production state within the near future. Chavez, however, would not name the weapons involved.

NATO Members To Produce Hawk

Paris—Five North Atlantic Treaty Organization nations of Western Europe have decided to pool their resources and to spend as much as $500 million in building the U. S.-designed, low-altitude air defense missile, the Army-Raytheon Hawk.

The unique agreement (AW Nov. 3, p. 30), to be announced shortly, marks the first success of U. S. policy established at the 1957 NATO summit conference. At that session, President Eisenhower promised NATO nations the U. S. would help establish in Europe large-scale production of advanced type of weapons.

Involved in the Hawk deal are five European companies representing Belgium, France, West Germany, Holland and Italy. They will be grouped into a sort of holding company, to be officially recognized by NATO. The holding company, rather than any particular national company, will retain Hawk license rights. United States negotiators insisted on such an arrangement despite the feeling of some nations, notably France, that license rights should be held by one national company.

This Europe-wide approach is likely to hold for any future agreements similar to the Hawk deal. United States officials are convinced it is the best way to make sure European NATO partners cooperate rather than compete when seeking U. S. weapons. In addition to the Hawk, U. S. officials are currently negotiating a somewhat smaller program under which Sidewinder air-to-air missiles may be built in some NATO countries. United States financial contribution to the European Hawk program is not expected to be very substantial. The five European nations involved have agreed to finance the program, with France and West Germany alone reportedly pledging some $500 million. These sums, of course, will be paid out over several budgetary periods.

What money the U. S. does put into the European Hawk program probably will come out of the $20 million earmarked in the Fiscal 1959 budget for the Facilities Assistance Program. This was set up to help Europe develop production of weapons such as the Hawk. European companies involved in the Hawk program are Ateliers de Construction Electrique de Charleroi, Belgium; Telefunken, Germany; Finmeccanica, Italy; Philips, Holland, and Thomson-Houston, France. It is expected that Thomson-Houston will be chief coordinator of the group. Each company will be prime contractor in its own country and will be responsible for subcontract work done nationally. In France, for example, Thomson-Houston is expected to subcontract missile body work to Nord Aviation.

It is no secret in NATO circles that certain member countries, particularly France, are not overly enthusiastic over the way the U. S. Facilities Assistance Program is working out. The French, and certain others, would like to see the money used to enable Europe-wide production of European-designed weapons.

Thus, while the French were willing to go along with the Hawk program since no similar weapon system exists in Europe, they probably will refuse to participate in the Sidewinder program. French companies have developed and have tested at least two types of air-to-air missiles, the Nord 5103 and the Matra 515, which they claim are superior to the Sidewinder.

New Technique May Trim Lead Times

By Philip J. Klass

Dayton – Representatives of more than a hundred avionic and airframe manufacturers and 18 universities jammed Wright Air Development Center's largest auditorium here for the first technical symposium on self-adapting flight control systems.

The two-day symposium on a fundamentally new technique for designing autopilots and other control systems which automatically adjust themselves to a changing environment to achieve optimum performance was sponsored by WADC's Flight Control Laboratory and USAF's Air Research & Development Command.

First details on new self-adapting flight control techniques were reported in AVIATION WEEK (Sept. 22, p. 60).

The report is credited by a Flight Control Laboratory spokesman with having stimulated intense industry interest which made it necessary for WADC to limit the number of representatives each company could send and still forced the command to turn away many who wished to attend because of 600-seat capacity of its largest auditorium.

Self-adapting flight control techniques are expected to greatly cut the time formerly required to develop systems for new aircraft, missiles and space vehicles.

They also look promising as a means of combining and blending aerodynamic and thrust controls for space vehicles during transition from atmosphere to beyond-atmosphere flight.

Self-adapting techniques are so new that fundamental theory has not yet been developed, even though several experimental systems are already flying in test aircraft. Even a precise definition of what is, or is not, a self-adapting control system was debated at the symposium.

Capt. R. R. Rath, who has spearheaded Flight Control Laboratory's self-adapting flight control system program to date, defined such a system as "one that maintains desired performance throughout required flight regime in closed-loop fashion with minimum of prior information about vehicle's dynamic characteristics and without an air data input" (information on vehicle's speed, altitude, air density).

Another definition, proposed by Dr. John Aseltina of Thompson Ramo Wooldridge Corp., would qualify a control system as being self-adapting only if it is capable of measuring system performance against an ideal norm, converting this to a figure of merit, then using latter to change system's operating characteristics to optimize performance.

Either definition disqualifies the conventional autopilot which changes its performance as a function of air data inputs in accordance with a pre-determined relationship (schedule) established by extensive flight tests on airplane in which autopilot is used.

One of the first applications of self-adapting flight control systems may come on the North American Mach 3 B-70 bomber and/or F-108 interceptor. Use of the new technique on these aircraft is under consideration, a North American Autonetics Division representative told AVIATION WEEK.

Meanwhile, number of experimental adaptive autopilots will be test flown in the near future, symposium speakers disclosed. These include:

• **National Aeronautics** & Space Administration will conduct fundamental investigation of adaptive control system techniques on a McDonnell F-101 using equipment produced by Sperry Gyroscope Co. Tests are scheduled to begin late this year. The aircraft also will be equipped to simulate handling characteristics of the B-70, F-108, X-15 and the Dyna-Soar orbital bomber, an NASA spokesman had reported.

• **Minneapolis-Honeywell** adaptive autopilot will be flight tested in an F-101A within the next several months. This will be a full three-axis system. Experimental pitch-axis-only adaptive autopilot, installed previously on an F-94C, has completed more than 60 successful flights, Honeywell's Luther T. Prince, JR., reported.

• **Aeronautic Systems Inc.** plans to test an experimental model of a self-adapting stability augmentation system on an F-100C airplane this spring, William Anderson reported.

• **Lear version of a system** developed originally by the Massachusetts Institute of Technology is scheduled for early flight evaluation on an F-100A.

Capt. Rath invited unsolicited proposals from any company or research group that believes it has worthwhile ideas in new fields. Day after the symposium, Flight Control Laboratory was nearly deluged by offers.

Although Convair-Ft. Worth was the only airframe manufacturer to present a paper at symposium, conversations with representatives of other airframe companies revealed that they are extremely interested in new concept and a number have investigations under way. Convair has been investigating self-adapting control techniques on a modest scale since 1956, Marcel Dandois reported.

General Electric, which has developed adaptive autopilot techniques with its own funds, expects to receive contract shortly from Navy Bureau of Aeronautics for an experimental system to be evaluated by Navy.

New self-adapting flight control system concept generally is credited to WADC's Flight Control Laboratory, although some claim it has traceable lineage from previous work in "optimalizing" techniques developed for engine control systems.

Widespread industry interest and activity in self-adapting control systems has been sparked by total Flight Control Laboratory investment of only $1.25 million, which includes all study programs, equipment and flight testing.

A wide variety of different design approaches have been developed within a short interval, the symposium disclosed. (Some of these were reported in AVIATION WEEK's Sept. 22 article.)

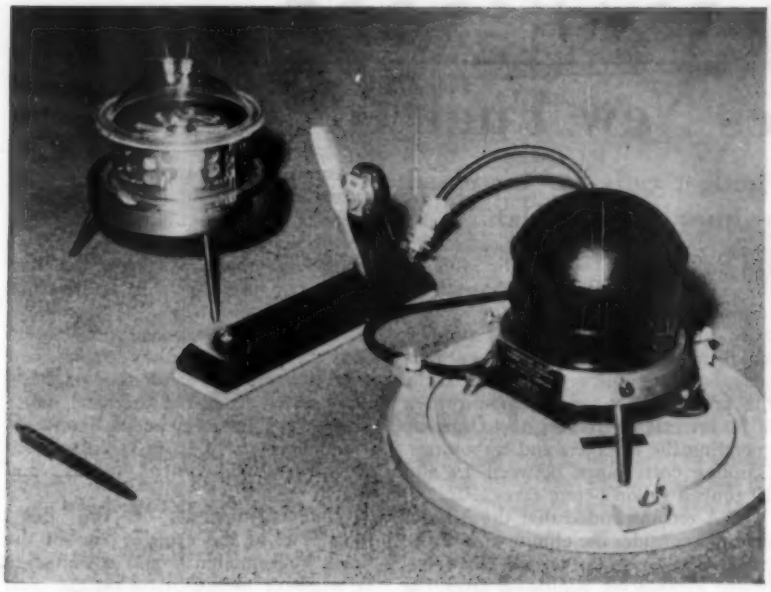
Representatives of many universities exhibited considerable interest in developing fundamental theory and suitable mathematical treatment for handling development of self-adapting control systems. A number of universities already have investigations under way, either under Air Force or private sponsorship.

Management Shift

Wright-Patterson AFB, Ohio—Air Materiel Command's management and budget programming responsibilities for seven Air Force electronic support systems have been transferred from AMC's Aeronautical System Center to the Rome Air Materiel Area (ROAMA) which is responsible for system equipment procurement.

For the present, the 36 AMC officers and civilians in the seven Electronic Support System Project Offices (ESPOs) will remain at Wright-Patterson AFB, but they may later be moved to ROAMA at Griffiss AFB, Rome, N. Y. In such an event, Air Research and Development Command personnel in the ESPOs may also be shifted. Projects involved in transfer include:

- **212-L: Base Air Defense Ground Environment (BADGE).**
- **314-L: Tactical Air Control System (TACS).**
- **431-L: Traffic Control, Approach and Landing System (TRACALS).**
- **438-L: Intelligence Data Handling System.**
- **465-L: Strategic Air Command Control System (SACS).**
- **466-L: Electronic Intelligence & Communications Intelligence System.**
- **480-L: Global Communications System (formerly 456-L).**



Thermoelectric Generator Drives Propeller

Radioisotope-fuel thermoelectric generator, designated SNAP III, has been developed for Atomic Energy Commission by The Martin Co., in conjunction with Minnesota Mining & Manufacturing Co. Generator at right drives a small propeller; pen in foreground gives a comparison of size. Generator at left is identical except for plastic shielding to show inner details. First application will be as power source for satellite instrumentation. Rated capacity is about five watts.

Thompson-STL Status Defined by Air Force

Washington—Air Force policy which excluded Ramo-Wooldridge Corp. from participating directly in ballistic missile and space programs for which R-W's Space Technology Laboratories held engineering and technical direction responsibilities, will be applied to the new combined Thompson Ramo Wooldridge Corp. The new firm was recently formed through the merger of Thompson Products and Ramo-Wooldridge (AW Dec. 1, p. 77).

Thompson Ramo Wooldridge will not be allowed to bid, either as a prime contractor, major subcontractor or team member on programs for which Space Technology Laboratories "has contractually accepted specific system engineering and technical direction responsibility," except with the approval of the Assistant Secretary of Air Force for Materiel. Such approval is not expected to be given except under unusual circumstances, an Air Force spokesman says.

Policy is not expected to prevent Thompson Ramo Wooldridge from bidding with Bell Aircraft Co. for Air Force's new air-launched intermediate range ballistic missile (WS-199), which is scheduled to be managed by Weapon System Project Office at Wright-Patterson AFB.

Official of Thompson Ramo Wooldridge concedes that company may consider divesting itself completely of ownership of Space Technology Laboratories. However, such a move probably could not be taken for at least a year. One reason is that Air Force would be reluctant to see Space Technology Laboratories cut adrift before it has had sufficient chance to establish itself as a separate operating entity. Another involves legal problems stemming from the recent merger, an official says.

If Thompson Ramo Wooldridge were to "spin off" Space Technology Laboratories at some future date in the form of STL stock to Thompson Ramo Wooldridge stockholders, top Thompson Ramo Wooldridge officials would become the largest single STL stockholders. An Air Force official declined to speculate on whether this would still leave a sufficient link between the two companies to require continuation of restrictions. Alternative would be to sell STL stock on open market.

A Thompson Ramo Wooldridge official says the Air Force policy is a "very real restriction" on the company but adds that "it is one we can live with." He points out that the STL programs represent only about 10% of the Defense Department procurement. Restriction does not apply to off-the-shelf items, like fuel pumps or digital computers which company produces for other applications.

News Digest

Atlas Score satellite apparently burned up over the Pacific Ocean at about 9:08 a.m. EST Jan. 21, 34 days after it was launched. Radio transmission had ended Dec. 31. Score was the first large object put into orbit by the U.S. and was used for a number of communications relay experiments (AW Dec. 29, p. 18).

Advanced Research Projects Agency's first launch attempt in Discoverer satellite series at Vandenberg AFB, Calif. (AW Dec. 8, p. 31), was postponed last week for "technical reasons," according to USAF. Launch preparations are expected to be resumed as soon as vehicle readiness permits.

Ryan Vertiplane completed its first conventional flight test phase at Moffett Field, Calif., at altitudes up to 5,000 ft. Transitions from normal flight to slow speed and hovering flight will be made soon.

Ernest W. (Walker) Brackett has been named director of procurement and contracting of the National Aeronautics and Space Administration. Brackett was formerly contract specialist and consultant to the director of procurement and production of USAF's Air Materiel Command.

Federal Aviation Agency has named Fordyce W. Luikart assistant administrator of personnel and training. (For other FAA appointments see page 23.)

Pratt & Whitney JT12 turbojet has been selected as the production engine for the four-jet Lockheed Jetstar high-performance executive aircraft. The JT12 develops 3,000 lb. thrust, weighs only 430 lb. First deliveries of production engines will be made in Oct. 1960.

Boeing Airplane Co. and General Dynamics Corp. increased their proportionate slice of total defense business during Fiscal 1958, according to Defense Department report on the 100 companies receiving the largest dollar-volume of procurement. The two companies received 16.2% of the total $21.8 billion defense procurement.

Development of a new type vacuum tube—a cold cathode tube—was announced jointly by U.S. Army Signal Corps and Tung-Sol Electric, Inc. Tube is said to operate on less than one-tenth the power of conventional tube, and to have very long life.

Industry Battles New Fuel Tax Proposal

Federal Aviation Agency budget calls for increased tax for gas, jet fuels; airlines protest plan.

By L. L. Doty

Washington—President Eisenhower's proposed budget for the newly organized Federal Aviation Agency was overshadowed last week by bitter industry reaction to strong recommendations for airways user charges in the form of fuel taxes to be covered by passenger fare hikes.

The proposed fuel tax, which would boost aviation gasoline taxes from two cents per gallon to four and one-half cents and place a four and one-half cents levy on tax-free jet fuels, immediately drew fire from the airline industry. Air Transport Assn. promptly charged that the airlines already were paying a fair share of airways cost. It added that the amount paid by the industry in fuel taxes last year was only slightly less than the total net earnings of the entire domestic industry for 1958.

In his message to Congress, President Eisenhower urged that fuel tax receipts be retained in the general fund rather than being transferred to the highway trust fund. In calling for a fare increase to cover tax costs, the President said, "These increased costs should be includible, along with other airline costs, in determining rates charged the ultimate users of air transportation."

In its attack on the proposed tax adjustment, Air Transport Assn. estimated the industry would pay $104 million in taxes in fiscal year 1961 under the proposed increase, compared to the $18 million it would pay under present tax rates. This would represent a tax increase of approximately $86 million. The ATA said the jet fuel tax cost on one turbojet flight from New York to Los Angeles would amount to $408, or the equivalent of four coach seats in terms of passenger fares.

Jet fuel costs to the airlines are now about nine cents a gallon when purchased in large quantities. As a result, the proposed tax would amount to a 50% increase in fuel costs to carriers operating the turbojets and turboprops. Gasoline costs range between 14 and 19 cents a gallon before taxes.

ATA recommended that the Administration consider the elimination of the present 10% excise tax on air travel before introducing additional taxes. In discussing the fare increase, FAA Administrator Elwood Quesada said the "application of this tax would be a minor burden to the air traveler . . . and it is just that he should pay it."

'Specialized Group'

He expressed the belief that the cost of airways facilities should be defrayed in part by "that specialized group" who use air transportation and added:

"A fare increase leaves an opportunity for the airlines to explore new service techniques" such as the economy fare plan now in effect on North Atlantic routes. He admitted, however, the tax would make all air travel "slightly" more expensive.

If the tax increase should be enacted by the Congress, the Board would be faced with this situation:

- **Findings in the General** Passenger Fare Investigation would require revision to reflect the increased costs imposed on the carriers.
- **Board will interpret** the President's message as calling for a study of the new costs rather than as a mandate to increase rates. Board will follow its basic policy of determining rate level on basis of rate-of-return.
- **Subsidies to local service** carriers will require new analysis to determine effect increase of fuel taxes will have on rate-of-return of this group.

Eisenhower also called for "an orderly withdrawal" from the airport grant program. He recommended legislation that would "authorize a transitional program of Federal grants to share the costs of basic facilities, such as runways and control towers" and added:

"One-half—instead of the three-fourths as in the expiring law—of the funds appropriated would continue to be available to the States on the basis of the existing apportionment formula. The other one-half would be available for expenditures on a discretionary basis."

He urged that revenue-producing facilities such as terminals and hangars should be financed locally. A total of $65 million of new obligational authority will be required for Fiscal 1960 to be followed by "somewhat smaller amounts" during the next four years, the President said.

Quesada said he was "satisfied" with the FAA budget and noted that he prepared a "tight budget" in line with the Administration's policy of "limiting Federal expenditures." The request provides for new obligational authority of $602 million, an increase of $37 million or 6.5% over the 1959 level.

A total of $326.4 million was requested for operation and regulation expenses for Fiscal 1960. The increase of $67 million over 1959 is attributed chiefly to the addition of approximately 5,000 additional positions within the FAA. During Fiscal 1958, Civil Aeronautics Administration was staffed by a complement of 22,763. By the end of Fiscal 1960, this complement is expected to be increased to an estimated 34,898 persons.

The agency has requested a $145 million appropriation for the establishment of air navigation facilities, a decrease of about $13 million below the amount appropriated to the CAA in 1959. According to FAA officials, the decline reflects a move toward joint use of military radar for air traffic control purposes. In addition, these officials say they are not "rushing headlong" into the purchase of equipment which has not been demonstrated as meeting long-term needs.

FAA will absorb 26 long-range mili-

Fuel Consumption and Tax Cost

Estimated amount of fuel that will be consumed by U. S. domestic carriers during the next four years and cost of proposed 4.5 cents tax to airline industry. Compiled by Air Transport Assn.

	Aviation Gas*	Jet Fuel*	Total Fuel*	Total Tax†
Calendar Year 1958	1,434	80	1,514	$68
Fiscal Year 1959	1,320	310	1,630	73
Fiscal Year 1960	1,148	766	1,914	86
Fiscal Year 1961	876	1,430	2,306	104
Fiscal Year 1962	684	1,947	2,631	118

* In millions of gallons.
† In millions of dollars.

First Boeing 707-320 Intercontinental Starts Flight Tests

First Boeing 707-320 Intercontinental, powered by four Pratt & Whitney JT4 turbojet engines, completed 7 hr. of testing in two days following its initial flight at Renton, Wash. (AW Jan. 19, p. 35). Also in production is Boeing 707-420 Intercontinental, which is powered by Rolls-Royce Conway Co. 10 engines. First 707-320 will be delivered to Pan American World Airways later this year.

tary radars during Fiscal 1960 and has proposed an additional 13 units be installed during the year. Emphasis will be placed on the implementation of Vortac and terminal radar during the year. Last year, a total of 449 VORs were converted to Vortac and an additional 109 Vortacs were installed for use on airways.

The agency also has requested an increase in appropriations to cover its research and development program. The $63.6 million requests includes $14 million to cover construction costs of the new National Aviation Facilities Experimental Center at Atlantic City, N. J., so that the total amount requested is actually $50 million.

For Fiscal 1959, $33.1 million was appropriated for research and development; in Fiscal 1958, only $16 million was appropriated for this purpose. In the budget request, emphasis was placed on theoretical systems analysis of proposed facilities, automatic data processing and display systems, long-range development of data processing techniques and development of an aviation weather system program as prime projects in the research and development plans of the agency.

According to Quesada, the budget for the Washington National Airport will remain at the level established last year and requirements for completing construction at the Washington International Airport at Chantilly, Va., will be submitted at a "later date."

CAB Asks $70 Million for 1960

Washington—Civil Aeronautics Board estimates that its fiscal payments will total $70 million, $14 million above its Fiscal 1959 levels.

Projected budget figures submitted for congressional approval call for a total of $62.6 million in subsidy costs in 1960 and $7.5 million in salaries and expenses. Current appropriations for these items are $40.7 million and $6 million respectively.

Subsidy Figures

The Board, however, has pointed out that the final Fiscal 1959 subsidy figures are expected to reach $58.5 million by the end of the year, reflecting $18 million in new and anticipated subsidy payments.

Bulk of the subsidy will go to local service carriers in 1960. CAB estimates payments of $48.9 million to the 13 local service operators; $4.8 million to three helicopter carriers and $7.1 million to seven Alaskan airlines. Anticipated payments to local service airlines in 1960 are an estimated $12 million beyond the Fiscal 1959 figure and reflect increased operating costs, estimated additional route awards and costs involved in acquiring new aircraft.

CAB expects to have 846 permanent positions in 1960 in accordance with staff increases authorized in 1959 in order to carry out its expanded workload involving route applications, commercial rates, international civil aviation, enforcement and safety. Most of the Board's expected $7.5 million appropriation for salaries and expenses will be accounted for by this staff increase of 116 positions over 1959 with the average CAB employe's salary estimated at $7,223 a year.

Workload of the Board will continue to mount, with CAB estimating that it will have 1,718 dockets uncompleted by the end of Fiscal 1960, exclusive of rate cases.

During that year the Board also expects to dispose of 311 out of 331 certificate and permit applications.

Piston Plane Disposal May Not Glut Market

New York—Disposal by airlines of used piston engine airplanes may not produce the glutted, cut price market that has been forecast, Todd G. Cole, vice president-administration and finance for Delta Air Lines, told the New York Society of Security Analysts.

"The status of the used airplane market is right fluid now," Cole said, "but we don't expect to take any big losses from the sale of piston engine equipment. If there is no real demand for our airplanes, they would be utilized in our own system—loosening schedules to get better reliability or for special flights catering to a special market."

Price is not a major factor in this market, Cole believes. If there is a need for a specific aircraft, a reasonable price will be worked out. "If the need doesn't exist," he said, "you can't create a need through pricing."

Cole also made these points:

- **Fourth crewman** may increase crew costs 15% for airlines affected, but Delta, which has employed pilot-qualified engineers, has no contract with the flight engineers and will use three crewmen.
- **Delta has no** plans for adding turboprop equipment.
- **All-cargo** flights have shown a slight loss but these flights account for only about 40% of the total freight carried by Delta.

Cole was highly critical of Civil Aeronautics Board practice of allowing competition on routes where service by one carrier had been satisfactory.

CAB has held that adequate service is not a bar to new competition but Cole said that CAB never demonstrated that the addition of a third or fourth or a fifth carrier benefits the public.

American Starts 707, Electra Service

By Glenn Garrison

New York—Making up the time lost in a three-weeks' pilot strike, American Airlines last week was to inaugurate on schedule its new services with Boeing 707-120 jets and Lockheed Electra turboprops.

Six daily Electra round trips between New York and Chicago were set to begin last Friday, with first transcontinental jet service following on Sunday in the Boeing jets. The 707-120s will make an initial one round trip daily between New York and Los Angeles.

Extension of the services will be slowed somewhat because of the lost time, however. A second transcontinental nonstop had been planned for Feb. 1, but now will probably be added around the middle of the month. New York-Chicago-San Francisco service with the Boeing, originally planned about the middle of February, now will be launched about Mar. 1.

Five daily round trips between New York and Detroit will be added to Electra schedules Feb. 10, and later in the same month two additional Electra flights to Chicago will be inaugurated. By that time, all de luxe "Captain's Flagship" flights, competitive with United Air Lines "Executive" schedules, will be operated with Electras.

Flight Origins

All Electra flights will operate out of LaGuardia Airport in New York, and will serve Chicago Midway and Detroit Metropolitan airports. The 707-120s will use New York International, O'Hare at Chicago, and the international airports at Los Angeles and San Francisco.

American's turbine fleet at the start of services was two Boeings and five Electras. Another Electra will be delivered by the end of this month, and deliveries of both aircraft will continue at the rate of about two a month. By the end of 1959, American expects to have received all 25 of its 707-120s and 25 of its 35 Electras.

The airline's 120s are in mixed configuration, with 56 two-abreast seats forward and 56 three-abreast seats aft. A six-seat lounge up front will serve the first-class passengers and will not be sold. American's Electras are all-first-class, with 68 two-abreast seats and a non-salable lounge.

New York departures on the first cross-country 707-120 schedules will be at 6:15 p. m., with Los Angeles departures at 8:45 a.m. Scheduled times are 4¼ hr. eastbound, and 5¼ hr. westbound. Electra time New York-Chicago is scheduled at 2 hr., 05 min. eastbound, 2 hr., 25 min. westbound.

To prepare for its jet operation, American set up its training flights at Idlewild much like regular schedules. Morning and afternoon flights left at specified times, and as high as 10 hr. of daily utilization was achieved with the airplane. The training program with supervisory pilots continued during the first week of the strike, which began Dec. 19, so only a couple of weeks were lost in this phase of the preparation.

American will tow instead of taxi its jets between gate and hangar at Idlewild, unlike Pan American. Reason is easier and safer ground handling over the long, circuitous route between the points, according to Hal Barenz, manager of operations at the airport. Another advantage, of course, is saving the 400 gal. per hour of fuel the 707-120 uses in holding operations.

The airline has built three passenger holding rooms, or departure lounges as the airline calls them, along an outlying finger of Idlewild's domestic terminal building. These enclosed cinder block structures cost about $75,000 each, according to Barenz. Figure includes blast fences, already installed at one loading point with installations for the other two holding room positions to be completed next month.

All of American's jet passengers, and probably piston schedules also, will be handled in these lounges. System should save loading time, because tickets are collected as passengers enter the lounges and they are ready to go when the plane reaches the gate. Similar principle is being built into American's own passenger terminal now under construction at the airport.

Some $1¼ million in special equipment for the jets is now at Idlewild, in Barenz's estimate. This includes a 25,000 lb., $25,000 tug, ground power unit, compressors, water injection truck, specialized rig to carry other water supply, hoist to load and unload baggage containers, special lavatory unit, self-powered stairs, special tools and a good deal of specialized maintenance equipment such as hydraulic servicing units.

American has a Boeing-built turbo-starter truck at Idlewild on a test basis, also is equipped with an "air cart" with compressed air start bottles for the 120s. Both Boeings and Electras will carry air bottles for engine starts. Eastern Air Lines is not using bottles, relying on external sources in all cases for its Electra engine starts.

American's Electra ground handling is more complicated than Eastern's in respect to fuel. American handles its own fueling at LaGuardia, whereas Eastern uses a service outfit to handle its Electra fueling. This means for American new tanks in its tank farm to store kerosene, and separate trucks.

The "baggage expediter" system of preloaded containers will be used by American in both its Electras and 120s. Containers are mechanically raised and lowered from the airplanes. Electra containers will hold up to 20 bags each; Boeing containers about 35 bags. The system will also be used in other types of jet equipment American has ordered for later delivery.

The airline's promotional plans for introduction of its two new planes were crimped by the interference of the strike. Elaborate tours and promotion flights had been worked up, but the program had to be scrapped.

Advertising, of course, also had to be rescheduled. American packed a few promotional flights into the short time left, but had some further bad luck from that standpoint when Chicago weather forced cancellation of trips to New York and to Chicago with the Electra.

Hearings Begin on Bill To Boost Airport Aid

Washington—Administration's cost-cutting plans for airport construction came under fire from congressional Democrats last week.

As the Senate Commerce Committee opened hearings on legislation that would boost federal airport aid from $63 million to $100 million a year, Sen. Mike Monroney (D.-Okla.), chairman of the Aviation Subcommittee, complained that the Administration proposes "to do less and less for aviation and increase its taxes more and more." Challenging the statement of House Republican Leader Rep. Charles Halleck that the Administration airport program of $60 million for Fiscal 1960 simply eliminates such non-essentials as "bars and fancy restaurants," Monroney pointed out that the legislation before Senate Commerce specifically excludes federal aid for "bars, cocktail lounges, night clubs, theaters, private clubs, garages, hotel rooms, commercial offices or game rooms or other uses. . . . not essential to the welfare and safety. . . ."

Monroney charged that the Administration proposal to increase aviation gas taxes from 2 to 4.5 cents a gallon and jet fuel from zero to 4.5 cents (see page 36) is another discrimination against aviation. "No tax penalty whatever is suggested with respect to railroads, which have been in the driver's seat for six long years in this Administration, while aviation has been penalized," Monroney charged in a Senate speech.

Vickers Vanguard Makes First Flight

Vickers Vanguard turboprop transport last week made its first flight from Vickers-Armstrongs (Aircraft) Ltd. Weybridge plant to the Wisley test airfield, after a month's delay due to engine trouble (AW Jan. 12, p. 49). Chief test pilot G. R. Bryce said the takeoff roll into a 15 kt. wind was about 1,590 ft. Aircraft flew for 17 min. at a gross weight of 95,000 lb.; entire first flight was made with landing gear in the down position at 150 mph. Vanguard is powered with four Rolls-Royce Tyne twin-spool coaxial shaft engines of 4,500 eshp. each.

American Trains Electra Crews

By Craig Lewis

Ft. Worth—With crew training completed for the initial Lockheed Electra schedules introduced last Friday, American Airlines is moving ahead this week with transition training for the pilots and engineers who will operate expanding Electra schedules as the aircraft are delivered.

Moving swiftly in the wake of the recent pilot strike, American had 10 line crews trained and ready last week to start initial Electra service between New York and Chicago. Electra training is done here at Amon Carter Field, while crew training for Boeing 707-120 service scheduled to start over the weekend is done in New York.

Electra training program now under way here is expected to last until June, using as many as three of the new aircraft at a time. Over-all training program is similar to those used in the past for transition to new aircraft, but some extra time is being devoted to ensure familiarity with such new features as the turbine engine and its propeller and the integrated flight system in the Electra.

Flight training on the Electra started here Dec. 5 with supervisory personnel. American had trained 12 captains and seven flight engineers and had just started on line crews when the pilot strike halted operations. Three line captains had completed transition work when the Air Line Pilots Assn. blocked further training just before the strike.

American and ALPA reached final agreement on their new contract on Jan. 11, and training resumed that day. One Electra was already at Carter Field, and two more flew down from Chicago that morning, carrying trainees and instructors. All the initial line crews were Chicago-based.

Crews put in a full half day of training that afternoon, and by the following Saturday, 26 trainees had completed their work. The initial 10 line crews were ready early last week to start flying the three Electras which will be used in new Chicago-New York service.

Before they come to Ft. Worth for flight work, the crews go through ground school. Since it is more economical to do the ground work at the home bases, crews will do all their preflight work there, then come here for up to a week of flight transition training.

Ground school involves two weeks and three days of training that applies to both the pilots and engineers, then the engineers get another week of ground training. This extra term for the engineers involves more detail on the systems and troubleshooting training that isn't necessary for the pilots.

After ground school, the pilots put in a minimum of 10 hr. in Link trainers to familiarize them with the Electra's integrated flight system. Training past the 10 hr. minimum will be done by pilots who need more time to attain proficiency with the new system. Link work is being done at New York, Chicago and Los Angeles bases, and some will be done here when the equipment is available. American will get an Electra simulator in about a month.

In flight training, captains get 10 hr., first officers six hours and flight engineers eight hours. Training syllabus for captains and first officers is the same, but captains are getting an extra four hours devoted mostly to engine handling and the new flight system. This 10 hr. program compares with six hours required on previous new aircraft types.

A normal training flight starts at 6:30 a. m. After an hour and a half of walk-around inspections and cockpit familiarization, the aircraft takes off and flies for four hours. The same schedule is repeated in the afternoon. A flight will carry a pilot instructor, two trainee captains, an engineer instructor and two engineer trainees. Two first officers replace the captains on the separate flights in which copilots are trained.

In the air, the trainees fly an hour and observe an hour alternately until each of the students has two hours of training and two hours of observing on each flight.

Flight training program was idle last week awaiting delivery of more Electras from the factory. Training will resume Jan. 30 and will involve from one to three Electras at a time, depending on crew requirements. Because of various imponderables, no total volume for the training program can be set, but previous experience indicates a normal average of about three and one half crews per airplane in service.

Average training day will be about 16 hr. of flying, but this may go as high as 24 hr. a day as crew requirements fluctuate. It takes about five days for a captain to get his 10 hr. of transition work.

Surcharge Reversal

Washington—Civil Aeronautics Board last week reversed an earlier decision on the jet surcharge issue and approved the extra fare for both first-class and tourist configurations.

Originally, the board authorized the surcharge on first-class fares on jet flights operated by National and American Airlines but refused to allow the carriers to apply the additional charge to coach seats. American, scheduled to begin transcontinental jet service yesterday, petitioned the Board to reconsider its initial order denying the request for a coach surcharge ranging from $3 to $10, the same surcharge approved by the Board for first-class flights. The Board's reversal followed the American petition by three days.

CAB Fails to Isolate Pacific Crash Cause

Washington—Reasons behind the mid-Pacific crash of a Pan American Boeing Stratocruiser with a loss of 44 lives on Nov. 8, 1957, still remain an unsolved mystery with the Civil Aeronautics Board which last week said it has insufficient evidence to determine the cause of the accident but is continuing its year-long investigation.

At the same time, CAB determined pilot error as the probable cause of a Braniff Airways Douglas DC-7 crash which claimed nine lives near Miami last Mar. 25. The Board noted that the in-bound ferry crew of the plane failed to report an engine malfunction on the aircraft but said the cause of the crash on a later takeoff after an engine caught fire was due to failure of the captain to maintain altitude during an emergency return to the airport because of his "preoccupation with an engine fire following takeoff."

CAB said lack of tangible evidence needed to investigate the Pan American crash has hampered its efforts and pointed out that the aircraft apparently broke up upon ditching mid-way between San Francisco and Honolulu. A week-long search of the crash area produced the bodies of 19 of the victims and evidence that a successful ditching may have been completed.

However, a pathological examination of the recovered bodies showed a high quantity of carbon monoxide, which the CAB feels may have overpowered the crew and caused the crash. On the basis of this theory, the Board said it is continuing its investigation.

Reconstructing the crash, the accident report said Pan American's Flight 7 was last contacted by a position report at 2:00 a. m. by the Ocean Station "November." The vessel failed to receive the next two position reports from the westbound flight, and a search was instituted with aircraft from the Navy carrier "Philippine Sea." The first bodies and debris were located 940 mi. east of Honolulu and 90 mi. north of the flight's intended track.

Recovered wreckage indicated the aircraft made a successful ditching since none of the recovered bodies were mutilated and drowning was listed as the probable cause of death for 10 of the 19 recovered victims.

Pursuing its theory of possible crew incapacitation because of carbon monoxide, the CAB said the most probable source of such a gas would be a powerplant failure which could cause a propeller or turbo supercharger disk to come through the fuselage, knocking out radio equipment, destroying the crews emergency oxygen supply, starting a fire and making emergency smoke evacuation procedures ineffective.

"Such an occurrence fits the known circumstances better than any of the other possibilities," the Board said.

In reporting its findings in the Braniff crash, the CAB called attention to the in-flight failures of the Curtiss-Wright Turbocompound engines used on the DC-7s (AW April 21, p. 38).

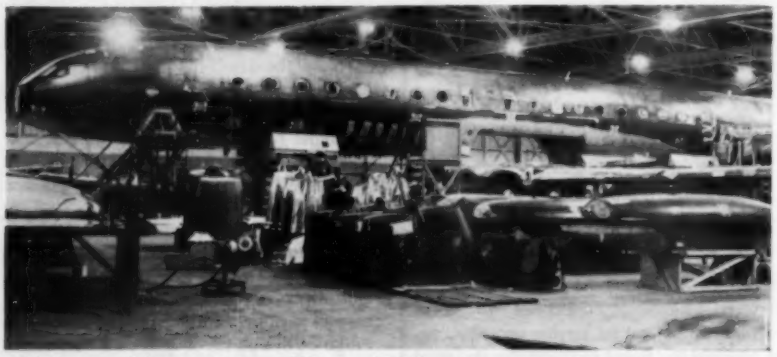
The Board said: "The problem of cylinder wall scuffing in the Turbocompound engines has been industry-wide. The Civil Aeronautics Board and the Civil Aeronautics Administration are studying the problems related to this model engine. The Civil Aeronautics Administration, on June 30, 1958, issued Airworthiness Directive 58-13-5. Part I of this Directive calls for the mandatory replacement of the second chrome-plated compression ring with a cast iron ring at first overhaul after Aug. 1, 1958, but no later than Mar. 1, 1959.

"Prior to the accident, Braniff Airways was in the process of replacing this chrome-plated piston ring on all of its engines as they reached overhaul. The No. 3 engine involved in this flight did not have the cast iron ring installed as the engine had not reached its overhaul period. Since the accident, all Braniff engines have been modified to replace the second chrome-plated compression ring with the cast iron ring in accordance with the Airworthiness Directive of June 30, 1958."

Braniff's International Flight 971 was originally ferried from Dallas to Miami where it was scheduled to depart for Panama City, Panama, en route to Rio de Janeiro, the CAB report said. The Miami tower controller twice reported smoke trailing from the plane's No. 3 engine as it approached the field to land. Although the crew acknowledged these reports, no mention of this was made when the ferry crew reported to the Braniff operations office. In addition, the arriving captain also reported the aircraft ready for Flight 971. He previously had signed the flight log which indicated no aircraft discrepancies, according to testimony.

Flight 971 took off after a routine preflight check which disclosed no discrepancies, the CAB said. Tower personnel said they saw the aircraft make a climbing right turn after which a bright orange glow was observed on the right side of the plane at an altitude of 900 ft. The aircraft was then observed to fall off on the right wing, and tower operators further testified hearing a call "Braniff 971" immediately prior to impact. The crash, in a swamp northeast of the airport, broke the plane into three sections and took the lives of the four crew members who had ferried the plane from Dallas and five of the 24 passengers on board.

Although the pilot was unable to recall every moment of the flight because of his injuries, the Board said the surviving copilot and flight engineer said the moment the fire was discovered, No. 3 propeller was feathered, a Freon tube discharged and the aircraft was placed in a shallow descent to the airport. Pointing out that the pilot had formerly experienced difficulty in maintaining altitude during turns in company check flights, the Board theorized the emergency "brought out his former difficulties" and charged him with "poor piloting techniques" by allowing his attention to be diverted from his flight instruments by the fire and emergency procedures being taken by the other crew members.



Wing Mated to First BEA Comet 4B Fuselage

First British European Airways de Havilland Comet 4B is shown on assembly line prior to mating of wing and fuselage. Comet 4B is clipped wing version designed to cruise at medium altitudes at about 530 mph., over stage lengths from 400 to 2,000 mi. carrying up to 102 passengers. Designers have added a third escape hatch on each side and increased length of fuselage 78 in. Nacelle tanks have been eliminated.

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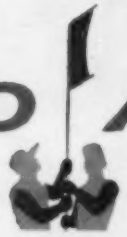

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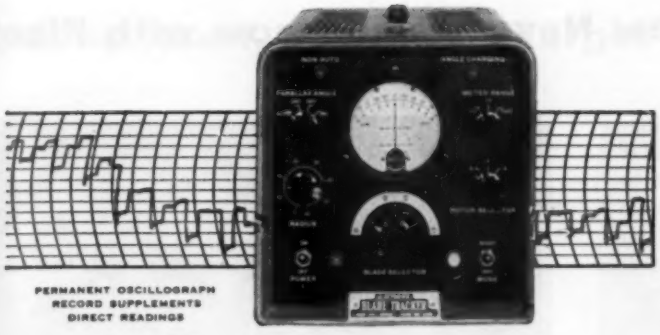

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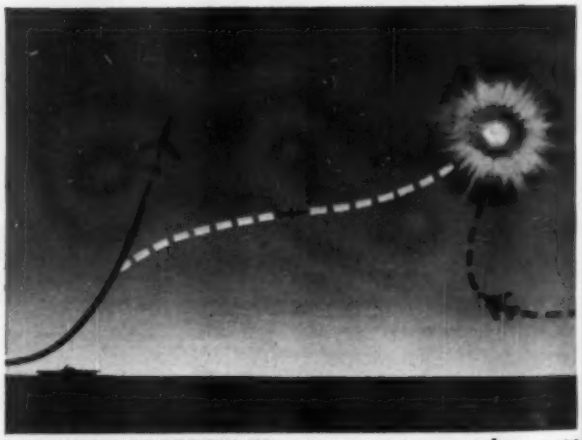
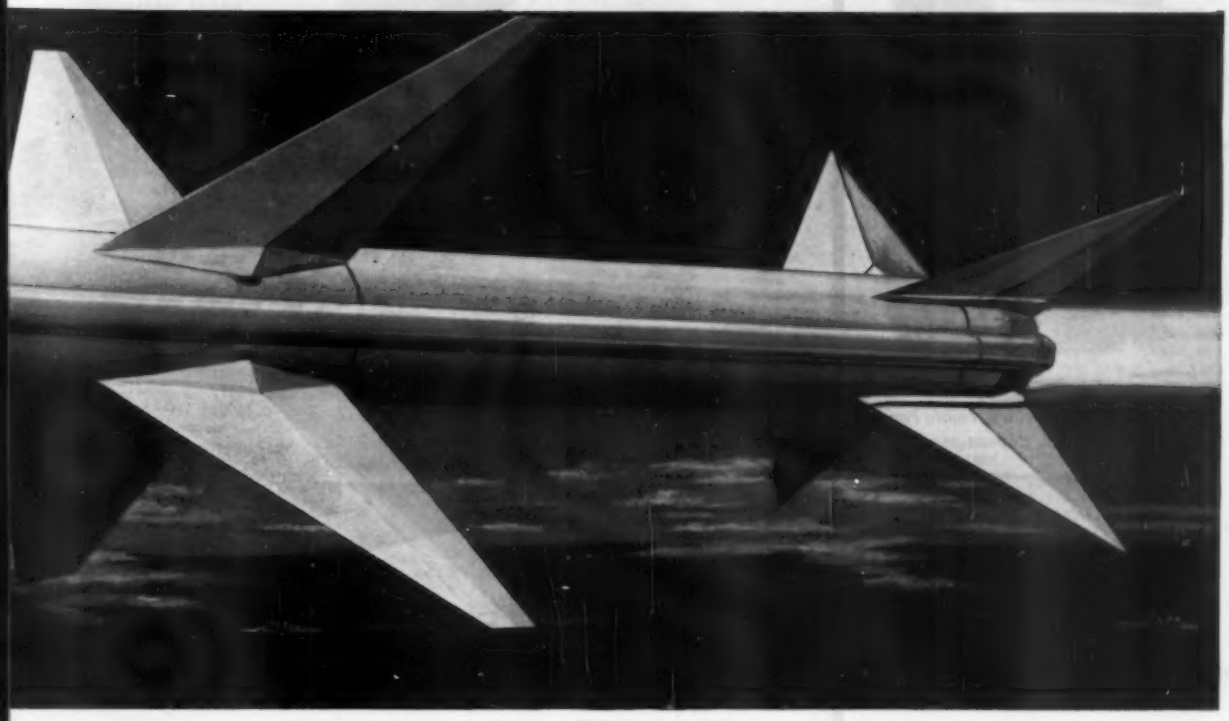
Now operational aboard Navy carriers, Sparrow III is slated for fighter squadrons throughout the Fleet. The missile is designed and produced for extreme reliability; has a powerful warhead and all-weather capability.

Raytheon is prime contractor for the Sparrow III, under the Navy's Bureau of Aeronautics. This new missile is another example of how the 37,000 men and women of Raytheon are contributing to national security.



RAYTHEON SPARROW III weapon system employs new "wide-angle" radar. Navy pilot can launch missile from almost any angle and hit the target. Missile guides itself automatically, relentlessly destroys enemy aircraft in spite of evasive tactics.

SPARROW III



guides itself, out-thinks target

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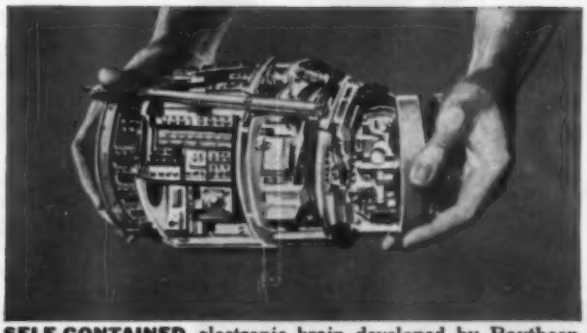

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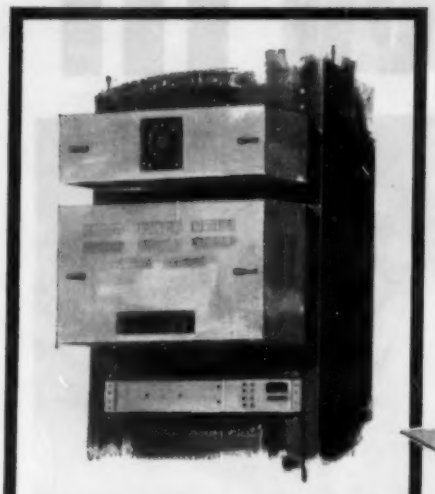

Collins RC-101 provides remote control of slave VHF stations.

Strategically spaced stations provide direct contact with aircraft anywhere on Delta's domestic routes. "C" indicates control center.

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unattended operation is key to Delta system

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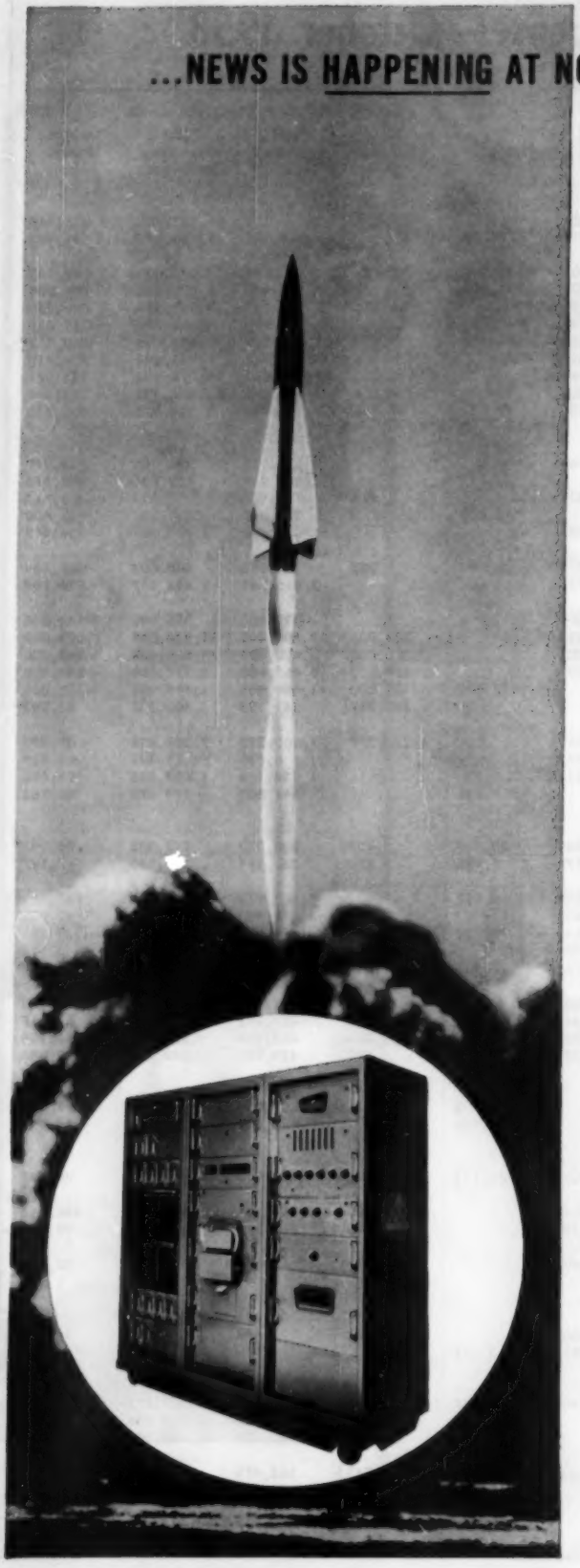
(IN DOLLARS)

	Passenger Revenue	U. S. Mail	Express	Freight	Charter	Total Operating Income	Total Operating Expenses	Net Income (Before Taxes)
DOMESTIC TRUNK								
American	26,350,279	650,323	2,775,452†	.....	38,994	29,910,346	25,723,890	4,025,446
Braniff	5,001,366	143,939	71,702	179,132	86,601	5,567,903	4,670,077	841,952
Capital*	.....	.....	.....	.....	.....	.....	.....	.....
Continental	2,325,867	48,000	22,000	50,000	26,436	2,531,784	2,456,930	−83,143
Delta	6,926,000	171,000	107,000	331,000	.....	7,780,000	6,824,000	908,000
Eastern	19,209,963	323,159	858,813†	.....	33,331	20,600,446	19,361,594	1,083,559
National	3,315,893	84,351	20,543	147,695	73,885	3,768,179	4,103,508	−361,814
Northeast	1,517,064	24,713	10,386	35,316	.....	1,621,682	2,532,099	−910,417*
Northwest	5,519,165	187,521	462,039†	.....	.....	6,251,448	5,341,694	909,753
Trans World	17,746,117	415,099	1,042,168†	.....	135,905	19,508,668	18,076,542	985,809
United	23,047,495	877,972	2,301,000†	.....	401,158	26,895,016	23,566,254	3,118,587
Western	3,777,201	94,581	31,210	97,451	47,741	4,100,592	3,581,998	438,285
INTERNATIONAL								
American	435,657	4,065	60,004†	.....	.....	520,016	587,646	−68,972
Braniff	520,531	10,520	.....	36,255	.....	614,219	689,725	−83,850
Caribbean-Atlantic	130,936	2,126	7,562†	.....	2,916	150,020	152,332	−1,978
Delta	330,000	6,000	.....	12,000	.....	336,000	429,000	−67,000
Eastern	1,542,167	31,632	72,109†	.....	.....	1,637,608	1,774,101	−136,493
Mackey*	.....	.....	.....	.....	.....	.....	.....	.....
National	341,590	3,693	1,757	12,096	8,342	378,593	340,404	37,594
Northwest	1,678,203	781,261	309,073†	.....	.....	3,095,641	2,418,857	676,784
Pan American								
Alaska	151,000	14,000	42,000†	.....	.....	222,000	365,000	−144,000
Atlantic	9,829,000	709,000	1,222,000†	.....	282,000	12,554,000	11,530,000	1,007,000
Latin America	4,621,000	191,000	1,178,000†	.....	370,000	6,628,000	7,526,000	−898,000
Pacific	4,086,000	613,000	926,000†	.....	619,000	6,462,000	6,171,000	284,000
Panagra	1,125,000	48,000	.....	172,000	21,000	1,468,000	1,595,000	−135,000
Resort	.....	.....	.....	.....	545,019§	545,129	482,337	62,792*
Trans Caribbean*	.....	.....	.....	.....	.....	.....	.....	.....
Trans World	4,695,744	502,050	450,151†	.....	1,278,577	7,205,293	7,201,226	−47,283
UMCA	5,331	.....	1,358†	.....	.....	6,689	11,628	−4,939
United	1,033,829	53,092	22,441†	.....	.....	1,124,198	1,007,205	105,683
Western	187,042	1,431	.....	846	.....	191,581	173,076	14,263
LOCAL SERVICE								
Allegheny	576,904	12,411	18,234	20,030	2,102§	835,353	815,308	20,045*
Bonanza	231,228	3,659	3,717	3,994	3,875	389,191	396,490	−7,107
Central*	.....	.....	.....	.....	.....	.....	.....	.....
Frontier	326,880	202,103‡	3,000	26,027	516	567,549	702,655	−141,489
Lake Central	211,820	4,904	9,495†	.....	1,112	379,493	337,072	42,421*
Mohawk	692,896	12,290	8,614	12,122	26,957	916,310	781,119	135,191*
North Central	823,102	25,520	19,308	.....	39,057§	1,176,759	1,169,449	2,064
Ozark	494,219	233,709‡	8,774	16,555	23,245	783,203	689,661	90,138
Pacific*	.....	.....	.....	.....	.....	.....	.....	.....
Piedmont	595,514	9,605	10,060	9,702	14,617§	871,587	764,782	117,973
Southern	254,036	8,025	5,144	6,825	19,650	497,967	439,484	57,017
Trans Texas	340,409	9,466	3,705	14,546	35,850	662,213	576,260	85,238
West Coast	300,494	4,475	1,555	6,699	570	459,779	533,678	−73,898
HAWAIIAN								
Hawaiian	381,686	3,817	.....	59,108	173,265§	621,485	663,193	−57,454
Trans Pacific	156,158	562	.....	5,253	611§	167,841	203,068	−35,226*
CARGO LINES								
AAXICO	.....	1,906	5,002	65,105	462,304	604,864	515,237	88,827
Aerovias Sud Americana*	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	.....	12,413	1,202,603	.....	2,226,215	3,397,785	2,866,286	450,256
Riddle	.....	6,186	560,839†	.....	306,185	874,152	965,391	91,239*
Seaboard & Western*	.....	.....	.....	.....	.....	.....	.....	.....
Slick	.....	.....	459,580†	.....	95,270	649,821	627,162	−20,290
HELICOPTER LINES								
Chicago Helicopter	54,392	101,517‡	.....	.....	.....	155,941	175,970	−24,478
Los Angeles Airways	16,260	11,262	13,466	.....	1,075	121,448	103,322	14,663
New York Airways	67,237	4,040	2,091	3,128	.....	280,850	240,559	35,461
ALASKA LINES								
Alaska Airlines	213,223	57,172	1,448	42,794	108,302	577,971	611,673	−41,840
Alaska Coastal	54,563	12,638	.....	7,817	3,338	107,022	125,586	−18,563*
Cordova	10,713	8,653	.....	4,447	27,402	83,627	89,229	−3,596
Ellis*	.....	.....	.....	.....	.....	.....	.....	.....
Northern Consolidated	68,037	38,697	.....	32,899	15,743§	165,171	191,396	3,291*
Pacific Northern	499,206	70,514	.....	98,309♦	5,262	820,139	797,436	7,580
Reeve Aleutian*	.....	.....	.....	.....	.....	.....	.....	.....
Wien Alaska	55,416	39,473	.....	22,817	132,805	325,737	374,525	−48,788*

*Not available. †Property figure. ‡Federal subsidy included.
§Non scheduled services. *Net operating profit or loss. ♦Cargo & express.

...NEWS IS HAPPENING AT NORTHROP



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SHORTLINES

► **Braniff Airways** estimates a year end 1958 net profit of $2,875,000, up 66.5% from 1957 and equal to 98 cents per share as compared with 59.59 cents per share in 1957. Airline officers estimate operating revenues of $69,510,000, operating costs of $63,280,000 and a cash flow of $9,320,000 (net income plus depreciation).

► **Canadair Ltd.** has sent its new turboprop transports, the four-engine, long range CL-44 and the medium-range Canadair 540, on tours of South America, England, Asia and Africa.

► **Central Airlines** has installed a new Bell Telephone System teletypewriter communications system which links all 34 cities on the airline's system.

► **C. M. "Casey" Britt** has resigned as vice president of Southern Airways to take a position as vice president of General Aircraft and Leasing Corp. in Washington. Britt, who also resigned as president of the Air Traffic Conference because of the change, will direct sales activities of the new organization, headed by Milton Arnold, former Air Transport Assn. vice president.

► **Frontier Airlines** carried over 227,000 passengers and flew them some 62 million passenger miles during 1958, a 6% increase over the previous year.

► **International Air Transport Assn.**, and Air Transport Assn. have formed a Joint Interline Communications subcommittee to work out arrangements for automatic transmission of complicated interline reservations messages over the linked teletype systems of the carriers in Europe, North America and over the North Atlantic.

► **National Airlines** reports an average monthly passenger load factor for the first month of its New York-Miami Boeing 707-120 turbojet flights of 95% southbound and 85% northbound. The carrier says over 10,000 persons have made the flights.

► **North Central Airlines** carried 777,140 passengers during 1958 for a 14% increase over 1957. The local carrier flew 117,573,865 revenue passenger miles, a 10% increase over 1957, and 11,260,865 revenue miles during the year for a 19% increase over 1957.

► **Scandinavian Airlines System** is scheduling Sud Aviation Caravelle turbojet airliner service to 24 European and Middle East cities for May 15.

AIRLINE OBSERVER

► Labor strikes against Eastern and American Airlines during December caused a 22% decline in domestic coach available seat miles during the month and a 26.5% drop in first-class available seat miles. Revenue passenger miles in both categories for the month plummeted 12.6%. Shortage of space was reflected by the 9.35% rise in passenger load factors which moved to 67%, highest level reached since June 1957.

► **Watch for some equity financing this year by domestic trunklines in a move to strengthen the equity base in relation to long-term loans. Airline stocks will be among the most active on the New York Stock Exchange in 1959, and dividend programs will be maintained and even broadened in some cases. Airlines have grown more interested in this type of financing now that current market prices are above book value.**

► Federal Aviation Agency is emphasizing that its complement of 200 military personnel represents less than 1% of the agency's total staffing of an estimated 28,000. Military personnel, however, are being assigned to FAA's headquarters in Washington which means this category represents 10% of the estimated 2,200 people based in Washington, or close to half of the 500 assigned to FAA's top-level management. Absorption of military air traffic control facilities by the FAA accounts for at least part of the new organizational pattern.

► **Foreign flag airline representatives are charging that U.S. carriers are responsible for the closed-secrecy under which recent technical and traffic conferences of the International Air Transport Assn. have been conducted.**

► Local service airlines will be the first to rebel against any legislation calling for an airways user charge in the form of a fuel tax (see page 36). Most feeder-line routes covered by local service carriers are without Vortac, ILS and terminal radar, facilities which the tax is designed to support.

► **Early estimates of 1958 traffic activities indicate that the number of passengers carried last year on domestic carriers is approximately the same as 1957's volume. However, chances are strong that the final figures may show a decline of as much as 1%.**

► Trans World Airlines has leased one Link Boeing 707 simulator for a period of 10 years to train flight personnel because, according to the Civil Aeronautics Board, the carrier anticipates "inauguration of jet service in the near future."

► **Netherlands is reacting strongly to British decision to cut KLM Royal Dutch Airlines service into Singapore to one flight weekly. Originally, the Dutch airline operated three flights a week but was forced by the British to reduce the service to twice weekly in September. KLM says the decision has caused "great astonishment" adding that such service can hardly be called a commercial proposition for any airline.**

► Look for demands by British pilots for a pay increase covering turbojet flights. Average top salary for British Overseas Airways Corp. pilots is about $11,200 whether they fly jets or piston-engine aircraft.

► **Russia and North Korea have signed an agreement authorizing Aeroflot to begin weekly Tu-104 service between Moscow and Pyongyang, the North Korean capital. The Soviet turbojets will fly the 4,000-mi. route in 12½ hr. including stops.**

► Red China plans to complete its network of domestic air routes within the next two years. Currently, domestic routes cover about 4,700 mi. in 13 provinces. Major portion of country's airline system was opened last year.

► **First transcontinental flight of a B-66 equipped with General Electric CJ-805 turbojet engines flew from Los Angeles to Andrews Air Force Base, Md., in 3 hr., 36 min. B-66 is being used as a test bed in a series of flights for the engines which will power the Convair 880 transport.**

SHORT discharge duct for fan air is one key feature of Pratt & Whitney forward fan engine. Cold fan air is exhausted through annular exit well forward on nacelle. This has been found to improve propulsive efficiency and does not increase nacelle drag.

Pratt & Whitney Evolves Turbofan From

By J. S. Butz, Jr.

East Hartford—Pratt & Whitney Aircraft, in entering the ducted fan field, is taking full advantage of the retrofit possibilities of its proven J57 turbojet, previous development experience with very large compressor and turbine blades, extensive company-owned experimental facilities and a previously unused idea incorporating a short discharge duct for bypass air.

Approximately one year ago, Pratt & Whitney began the detail design of a forward fan engine that would provide 50% more takeoff thrust and 13% better specific fuel consumption at cruise than that of the J57 engine. Increase in propulsive efficiency in the new engine would make its noise level about 10 decibels quieter than the basic J57, or roughly equivalent to the J57 equipped with a current sound suppressor nozzle.

This engine, designated a turbofan by the military, would handle almost 2.5 times more air than the J57 yet use about 90% of its parts. It also was stipulated by the company that the conversion from the J57 to the turbofan configuration would not require factory rework and could be accomplished in an overhaul shop.

Design Objectives

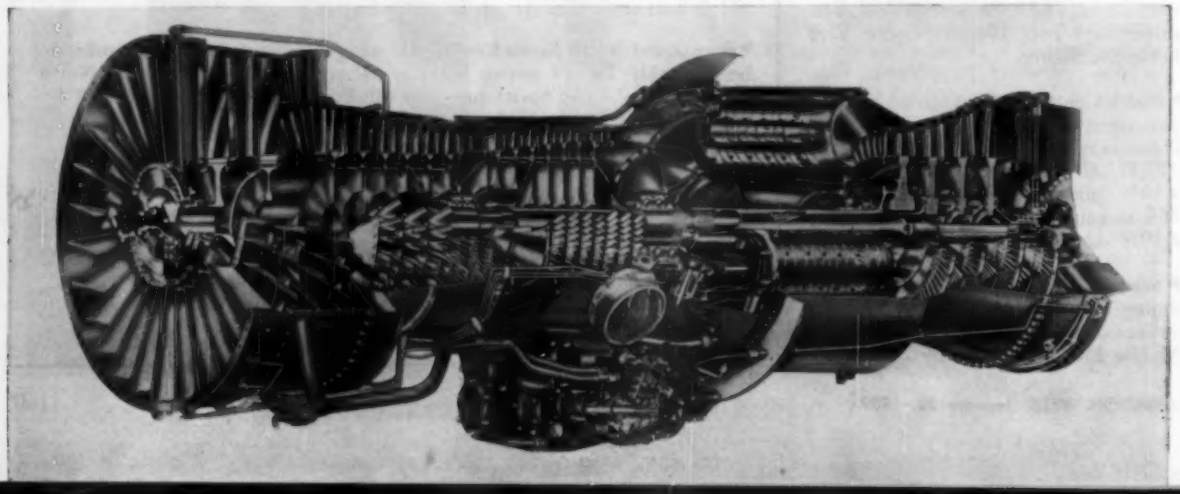
These design objectives were accomplished through three main moves:

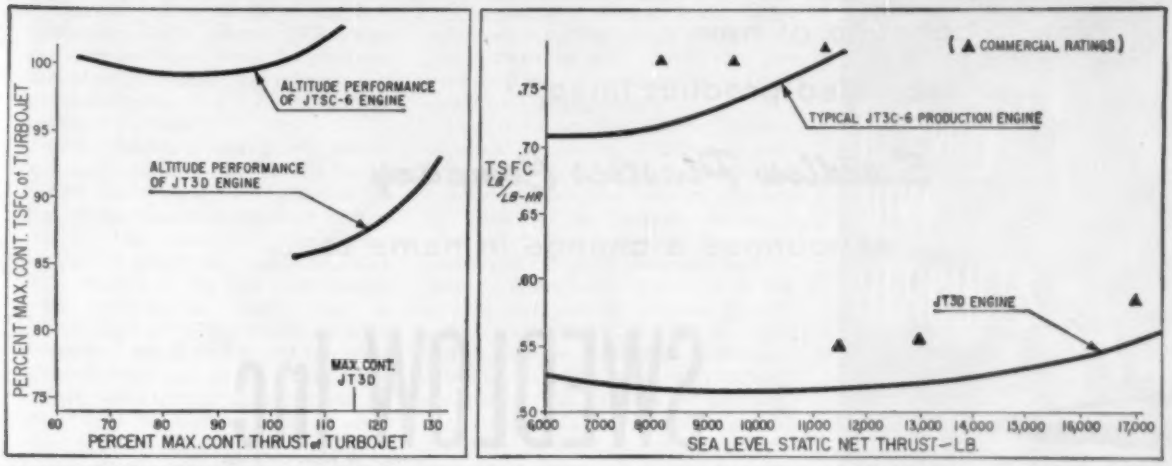
- **First three stages of the** J57 compressor were removed and two fan stages added.

These fan stages used the large advanced compressor blades developed in its J91 nuclear turbojet program.

- **Third stage turbine** on the J57 was enlarged and a fourth stage added to provide the power necessary to drive the low pressure compressor rotor and the fan, both of which are integral. The low pressure rotor shaft also was strengthened to transmit the added power to the fan which produces about 50% of the thrust in the Pratt & Whitney turbofan engine. Blades used in the new third and fourth turbine stages are very long and thin and were made possible through knowledge gained in the T57 turboprop program which has been dropped by the government.
- **New short discharge duct** was designed to exhaust the fan air well forward on the engine nacelle just after

CUTAWAY drawing of the Pratt & Whitney JT3D-1 turbofan engine shows its genisis from the J57 turbojet (civil designation JT3). Primary changes in transition to turbofan model are in first three compressor stages and the addition of fourth turbine stage.





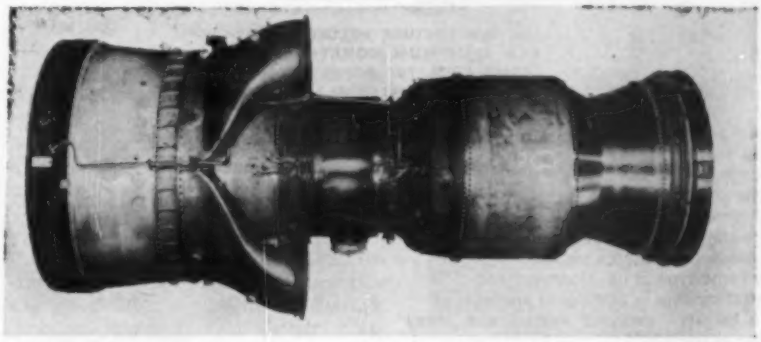
IMPROVEMENT in J57 performance gained through conversion to the turbofan configuration which has been demonstrated in Pratt & Whitney tests are shown here. At left the percentage improvement in specific fuel consumption at altitude is shown. These data points were taken during altitude chamber tests on experimental turbofan engines at Pratt & Whitney's Willgoos Laboratory. Comparison of absolute values of specific fuel consumption at sea level for the J57 and its turbofan development are shown at right.

J57 Program

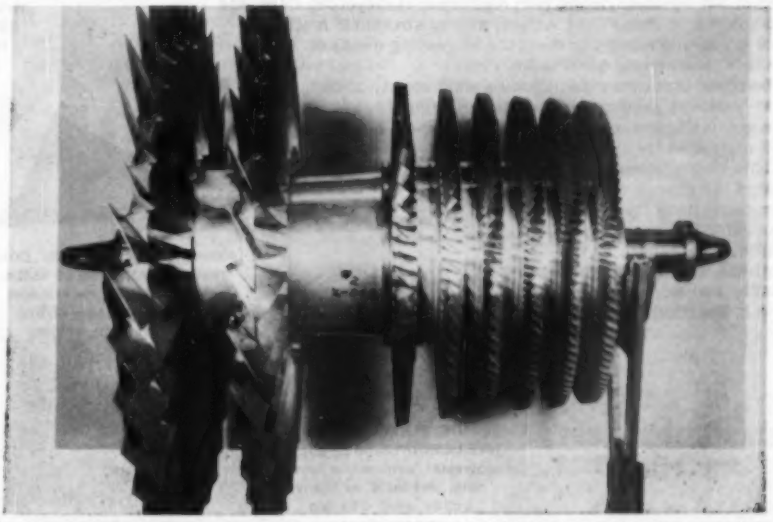
it passed through the fan. This procedure cut the pressure losses, which are inevitable if the bypass air travels the length of the engine through an enclosed duct and is then exhausted with the hot high speed air from the turbine. Pratt & Whitney wind tunnel tests have shown that there is no measurable increase in nacelle drag for the turbofan engine when the fan air is exhausted forward on the nacelle. Engine tests also have shown that propulsive efficiency has been increased by the desired amount with the short discharge duct and the predicted values for takeoff thrust and cruise specific impulse have been achieved.

Company engineers say that the short discharge duct and their work in 1957 with large compressor blades were the two factors that had the greatest influence in taking Pratt & Whitney's ducted fan work from the theoretical to the hardware stage. Up until that time Pratt & Whitney's paper comparisons between straight turbojets and bypass and turbofan engines had not convinced them that straight turbojets could be improved upon enough to warrant a turbofan development program.

This picture was reversed to the company's satisfaction when the 16-in.-long compressor blades for the J91 proved practicable. Two stages of these blades could do the work of three stages in the J57, and they were of short chord so that their attachment problems were not severe despite their great length and the large centrifugal loads that they carried. These two factors allowed a much



LARGE diameter of turbofan and bypass engines is illustrated in top view of the JT3D-1. Outside diameter is 53 in. compared with 37 in. on J57.



COMPRESSOR blades similar to these developed for the J91 nuclear turbojet are used in the fan section of the JT3D-1. Approximately 16 in. long and of narrow chord, these blades are supported by a shroud located about two-thirds of the span out from the hub.

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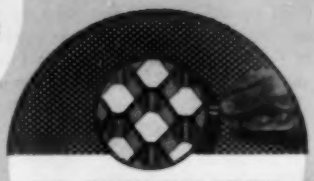

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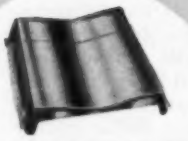

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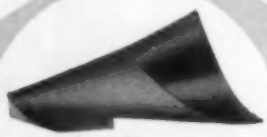

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Swedlow products also include a wide variety of high heat-resistant reinforced plastics, utilizing fibre glass with silicone, phenolic and epoxy binders and metalized for extra heat protection.

This diversification and expansion makes the change to a more inclusive name desirable. In all of its products, the company will continue to adhere to the highest standards of quality and workmanship in the future.

SWEDLOW Inc.

LOS ANGELES 22, CALIFORNIA / YOUNGSTOWN 9, OHIO

Refer Dept. 10

lighter fan stage to be constructed than had been possible in the past.

Unusual feature of these very long compressor blades (almost 50% longer than any in the J57) was the part-span shroud or interconnecting supports that are located about two-thirds of the span out from the hub.

Such shrouds which greatly reduce vibration problems on heavily loaded slender blades usually are located at the tips of the blades as on most turbine stages. The part-span shroud was adopted to reduce the weight necessary for a shroud at the tips even though some aerodynamic penalty was involved. Each of the fan blades has small sections of the shroud forged integrally on the forward and aft side of the blade so that, when they are assembled on the rotor hub, the sections rest on each other to form the complete shroud.

The short discharge duct improved the turbofan picture through weight savings and a reduction in engine pressure losses. Original Pratt & Whitney work with this type duct was with a relatively restricted configuration that did not have a large exhaust area. It is believed that this first experimental duct can be improved upon for most current transports and bombers.

Exhaust for the fan air would extend as far as possible around the nacelle. A relocation of some of the engine accessories that are normally bunched at the bottom of the engine could make it possible for the short discharge duct to extend completely around the nacelle except for the pylon supporting the engine on some aircraft.

When Pratt & Whitney formed the project early in 1958, the general design parameters set down for the JT3D-1 turbofan included 16,000 lb. takeoff thrust; a bypass ratio of 1.4, meaning that 40% more air would pass through the fan than through the main engine; pressure ratio across the fan was to be 1.6. In general, these original requirements have been slightly exceeded. Four turbofan engines are now running, with an over-all time of about 300 hr. One of these engines has more than 90 hr. on it. Much of this time has been obtained in Pratt & Whitney's Willgoos Laboratory. A complete calibration of the engine has been obtained at all design altitudes and to speeds of over Mach 0.8, the cruise speed of most of the aircraft that would use the present turbofan most effectively.

Pratt & Whitney management credits the extensive facilities at the Willgoos Laboratory with providing such a short lead time in engine development. Test work can be expedited considerably when the company has control over the test facilities as well as the programs.

In this case, the complete exhauster system for the engine test cells at the Laboratory had to be utilized to provide the 450 lb./sec. airflow required for the turbofan engine.

The company plans to direct 50 hr. endurance tests this month at the Willgoos Laboratory with the 50 hr. preliminary flight rating test for the military sometime this summer.

First deliveries of production engines are scheduled for July, 1960, with certification testing being completed earlier.

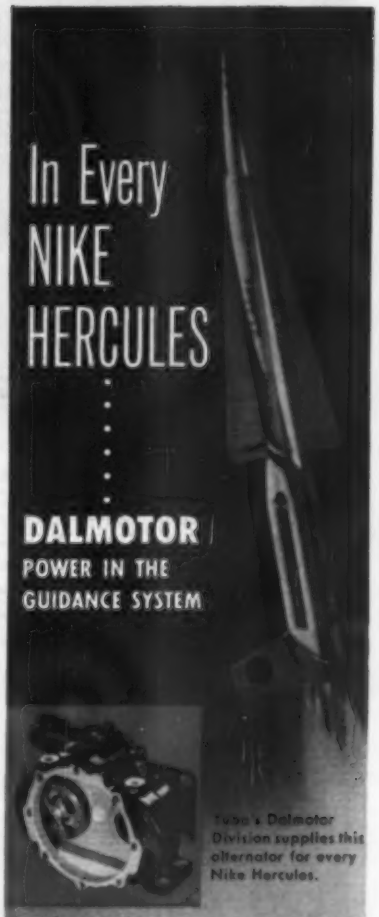
Some of the considerations affecting the choice of the forward fan design other than the improved compressor blades and the short discharge duct include good accessibility afforded to the rotating parts and the accessory groups; a great possibility that foreign object damage will be reduced because much debris would be thrown radially outward and pass out of the fan air discharge duct rather than traveling through the entire compressor and turbine sections; the engine center of gravity is essentially unaffected by the modification from the straight jet J57 to the turbofan version because moments of fan section around center of gravity balance those of added turbine stage.

Engine starting and acceleration characteristics also are unchanged in the conversion to the turbofan model. Starting loads are virtually the same, as the high pressure rotor is the only one cranked on the two-spool J57. As the internal airflow through the hot part of the engine is essentially unchanged when the forward fan is added, the acceleration curves for the turbofan engine are about the same as those for the basic J57.

The designation "turbofan" apparently has been chosen by the military for powerplants similar to the Pratt & Whitney engine and the General Electric "aft-fan" development of the CJ-805, civil version of the J79. Distinction between these engines and the Rolls-Royce Conway, the first bypass turbojet, is that they do not duct bypass along the full length of the engine and then mix it with the hot turbine exhaust gas before ejecting the combined flow through a single exit as does the Conway.

Some authorities evidently include a comparison of the bypass ratio as well as the internal air flow pattern when making a distinction between "fan" and "bypass" engines. According to this classification, "bypass" engines would have less than half their total air flow being bypassed and "fan" engines would have more than half. The first Conway, for instance, has a bypass ratio of about 0.6, or the bypass airflow is equal to 60% of the main engine airflow. The Pratt & Whitney and General Electric "fan" engines have a bypass ratio of around 1.4 to 1.5.

The classification of these turbojet variants, however, is far from being standardized at present.



Yuba's Dalmotor Division supplies this alternator for every Nike Hercules.

It takes many proven components to make a missile system operational. In the ground-to-air Nike Hercules, the important AiResearch auxiliary power unit drives Yuba's Dalmotor 3-phase 400-cycle alternator. Designed specifically for this air defense application, the alternator powers the missile's electronic guidance and control system. The work of this small, vital unit is such that it must meet extreme environmental conditions of heat, cold and shock.

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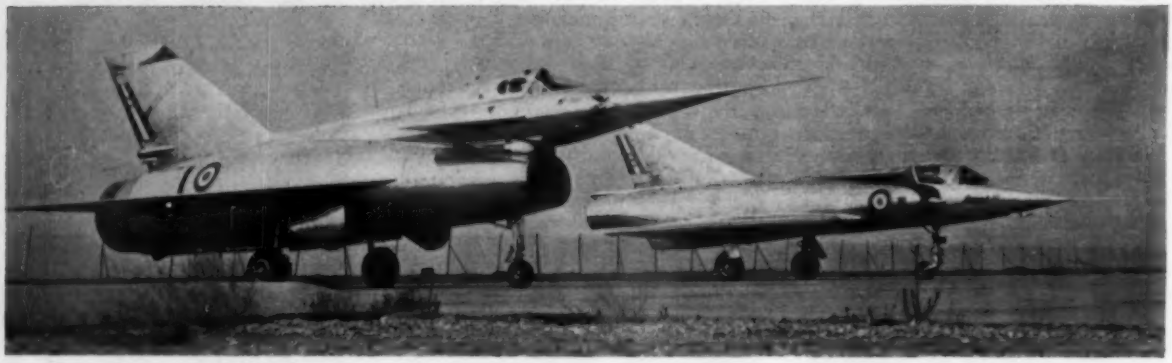
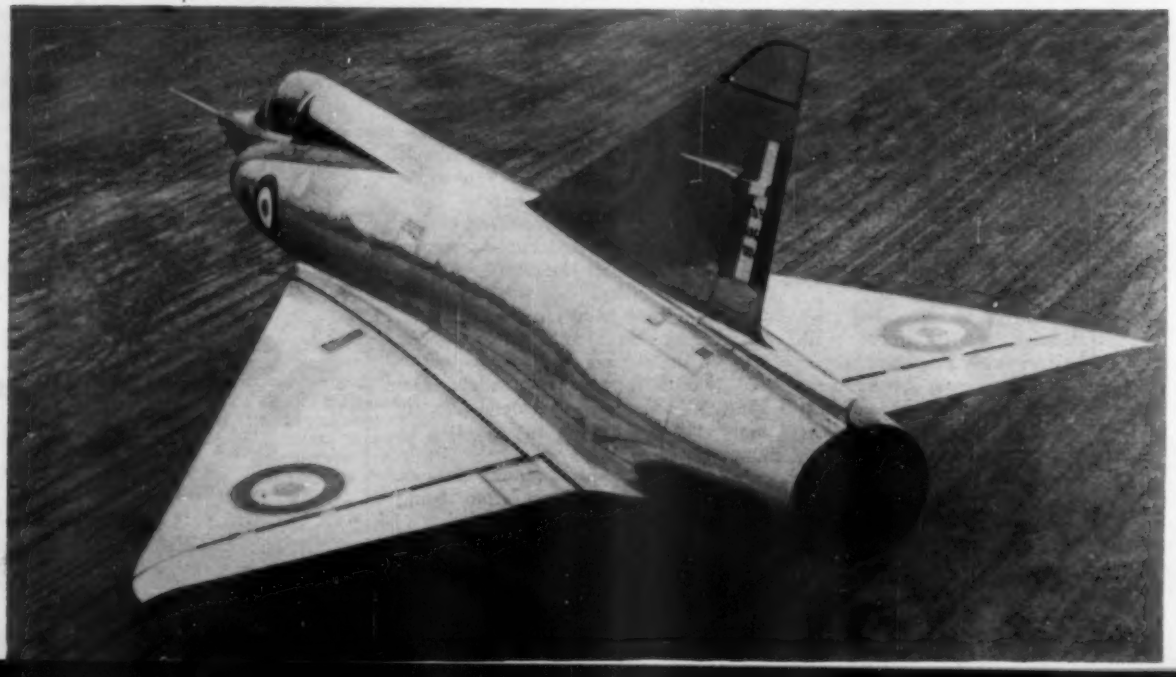
Nord Griffon experimental turbojet-ramjet fighter shows little external design change in its newest flight photo. One addition is the ventral strake on the belly for fuel tank or missile mounting. Grid on belly below wing root is a speed brake. Important modification to the inner and outer rings carrying the 150 fuel injectors in the ramjet permits cutting in rings separately. Nord says this permits stabilizing Mach number between Mach 1.3 and 2.1. Manual operation is necessary now but will be replaced by automatic selection system. Fixed inlet geometry is valid up to Mach 2.5, Nord says. The aircraft, which has made 180 flights, has enough power to go beyond the Mach 2.1 speed it has flown, but is held back by possible heating problems. No money is earmarked for airplane in 1959 budget, but Nord can draw on funds available for ramjet studies. Griffon and Dassault Mirage IIIA are parked side by side (below) at France's Istres Test Center.



Design Details of Nord Griffon, Mirage IIIA

Area ruling of Mirage IIIA fuselage and conical camber, visible most easily at wingtips, shown in photo below.



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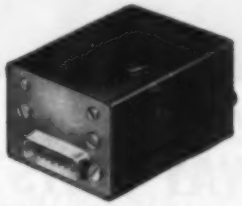

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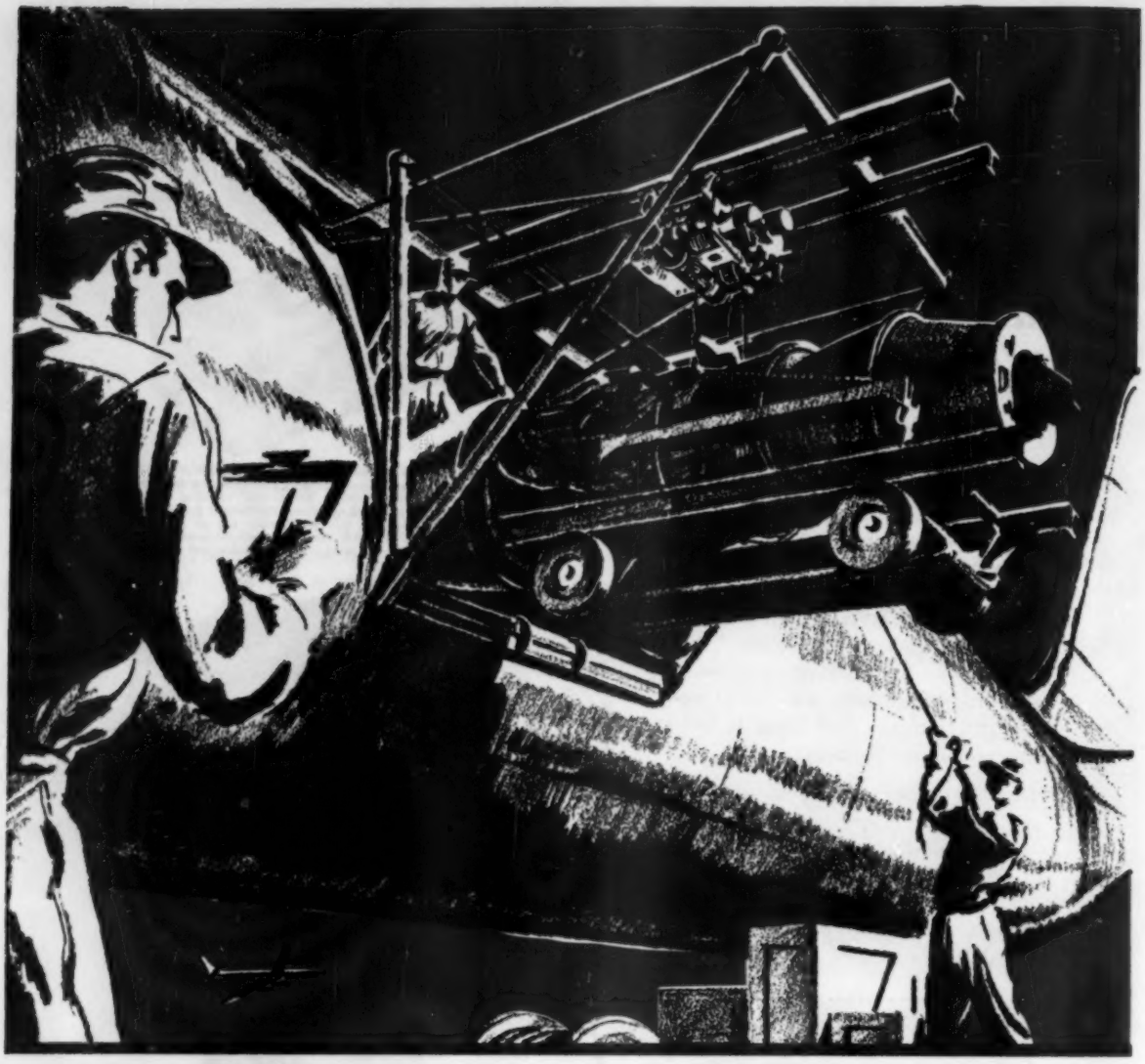

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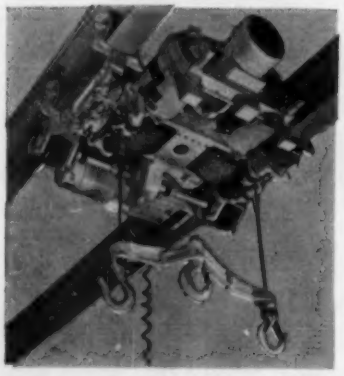

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Mechanical Controls Designed for B-70

Dayton, Ohio—All-mechanical flight control system for which Curtiss-Wright Corp. has received an Air Force contract (AW Jan. 19, p. 35), is designed to withstand the exceptionally high temperatures anticipated in Mach 3 aircraft.

Operational capability of the new system is expected to extend from —100F to 1,000F.

First applications of the system in operational aircraft are expected to be in North American's F-108 and B-70. Many other aircraft manufacturers reportedly are interested in the system. Among them is Boeing Airplane Co. which has been supplying Curtiss-Wright its requirements for the Dyna-Soar in an effort to find out where and how the mechanical flight control system might fit in.

The system, which would move all missile or aircraft control surfaces on signal from a computer or pilot, is designed as an alternative to hydraulic control systems in which the development of suitable high temperature hydraulic fluids is currently proving a fairly formidable problem (AW Jan. 5, p. 71).

Phase I, on which Curtiss-Wright is prime contractor, calls for a feasibility study of the system, which the company has had under development for some time, and is expected to take only a fraction of the budget. Phase II, which will take most of the time and money, will involve the development of actual hardware. In awarding a contract for this phase, Air Force is expected to name North American prime contractor and Curtiss-Wright as the principal subcontractor.

In all, four complete systems will be required for laboratory and flight testing.

The first test unit will simply be a lateral control system involving the ailerons just to show that the system will work. It will be installed on an F-100 jet fighter which has been chosen as the flight test bed. At all times throughout development and modification of the units, designers and engineers will be concerned with trying to make the system fit the F-108.

Cargo Conversion Kit Designed for Electra

New York—International models of the Lockhead Electra turboprop transport will be offered to customers with an optional cargo conversion kit giving the aircraft a combined cargo-baggage capacity of 11,360 lb.

Cargo kit, intended for use on routes with less than normal passenger load factors, is installed after removal of forward seats. Included in the conversion kit are protective coverings for the side walls, partitions and floor, cargo barrier nets attached to posts anchored in ceiling and floor, and web-strap retainers fore and aft.

Society to Reward Weight Optimization

New York—An annual award for significant developments resulting in lighter weight in design of aircraft flight systems or components has been established by the Society of Aeronautical Weight Engineers.

The award, consisting of a medallion and $500, will be presented in May at the 18th annual national conference of the society. Any person or group working in the areas of materials, design, manufacture, operational use, management procedure or related research and development is eligible for nomination.

Nominations will be accepted until April 1.

Award committee chairman is E. Joseph Weber, chief, weight optimization engineering, The Martin Co., Baltimore 3, Md.

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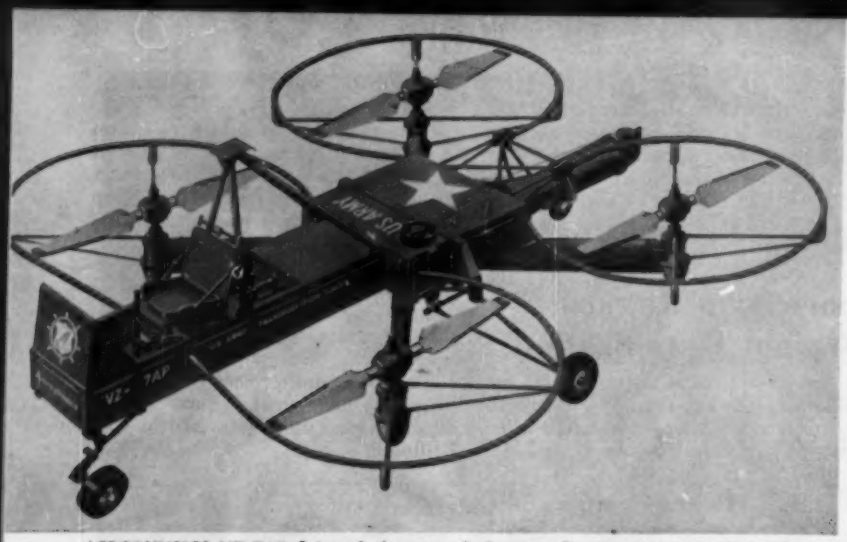
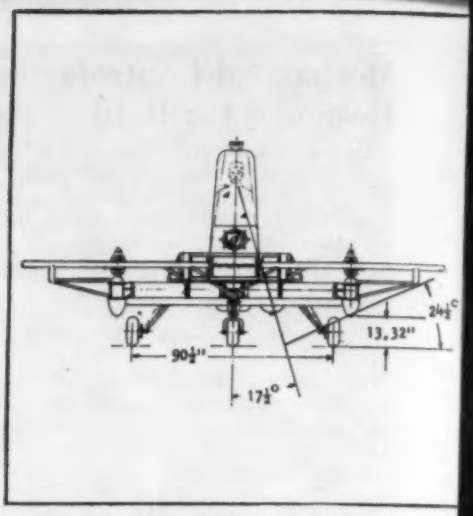




AEROPHYSICS VZ-7AP flying platform test bed uses rudimentary ring-guards around rotor-props to minimize drag and nose-up pitching in forward

PIASECKI VZ-8P test bed, first to fly, has rear shroud higher than front unit to minimize rotor-prop downwash. Tripod next to pilot's seat, is for test fitting of 105-mm. rifle.

CHRYSLER aerial platform, scheduled for rollout late next month, has complex system of vanes and cascades to provide forward thrust, cancel-out nose pitchup phenomena.

Designers Face

Detroit—Considerable research and development faces industry and U. S. Army Transportation Research & Engineering Command in solving the numerous stability and control problems inherent in the flying platform concept in the face of a paucity of basic and applied research data available.

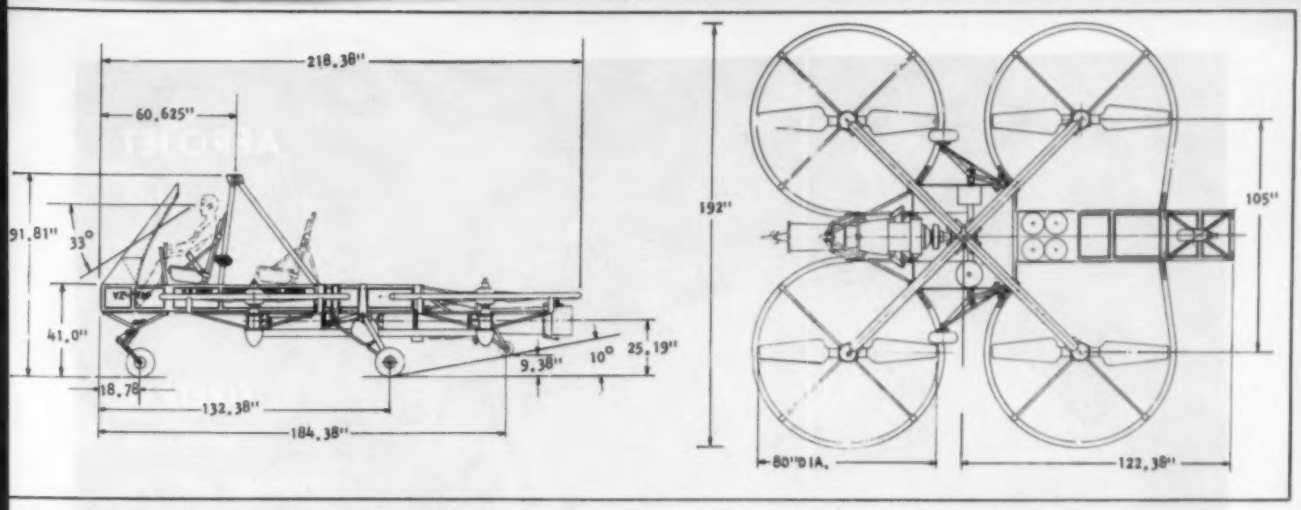
With a relatively small core of information to work with, the trio of winners of TRECOM's aerial platform competition will have to rely primarily upon their own resources backed by the lessons they learn as a result of flight testing the six test bed vehicles ordered by TRECOM.

First details of the three varied approaches taken by Aerophysics Development Corp., Chrysler Corp. and Piasecki Aircraft Corp., which are building the first tangible hardware to test their theories, were divulged by company representatives during a recent Society of Automotive Engineers meeting in Detroit, with discussion of National Aeronautics and Space Administration research in this field by an engineer from Langley Research Center.

Each of the three contractors will build two test bed configurations of their proposals under the current Army contract—award of production vehicles will await proof of the concept's feasibility. In addition to developing a stable, useful vehicle, Army will consider cost a prime requirement, probable quantitative procurement will most likely be inversely proportional to production costs, Larry M. Hewin, of TRECOM, pointed out.

Vehicles discussed at Detroit were:

• **Chrysler tandem duct** piston-powered platform, scheduled for rollout late in February, which features rigid rotor-propellers and a system of vanes, louvers



flight. Only turbine-powered platform of three in TRECOM competition, VZ-7AP has 425-shp. Turbomeca Artouste.

Flying Platform Controllability Problems

and cascades to provide propulsion, stability and control.

• **Aerophysics VZ-7AP** controllable-pitch four rotor-propeller platform, powered by a 425-shp. Turbomeca Artouste IIB turbine, currently under construction.

• **Piasecki VZ-8P** tandem-duct platform, with three-blade rigid rotor-propellers, which has been flying since October at Philadelphia International Airport, Pa.

Pitch, Roll Stability

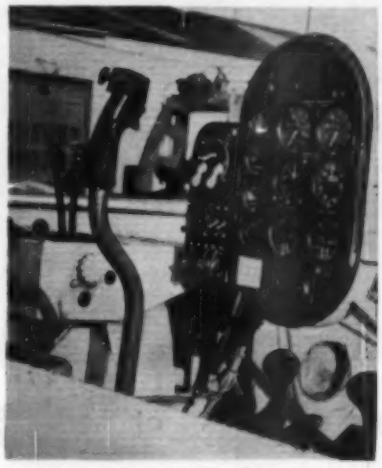
Unstable oscillations in pitch and roll are fundamental stability characteristics of the flying platform in both hovering and forward flight, it was pointed out by NASA research engineer M. O. McKinney, who provided data based on limited model tests.

In the case of the unshrouded rotor-propeller, a downwash on the rear portion of the prop disk, caused by the forward part of the prop disk, reduces the thrust of the rearward portion of the disk and provides a nose-up pitching moment. For a shrouded rotor-propeller, the downward flow is deflected through the duct at a larger angle, leaving it parallel to the propeller shaft axis and providing a larger drag than that of an unshrouded propeller.

In the case of cross flow across the shroud, there would be an increase in flow over the leading lip of the shroud and decrease over the rearward portion, causing unequal pressure distribution and also very likely, unsymmetrical thrust distribution—these being additive, there would be a nose-up pitching moment larger than for the unshrouded rotor-propeller.

In the case of a tandem configuration, pitchup would be aggravated, since downwash of the leading rotor-propeller on the rear unit would decrease the latter's thrust. Damping of the resulting oscillation was less critical for a two-shroud tandem configuration than for a four-shroud model tested by NASA because the latter had a shorter moment. Rolling oscillation of both two and four-shroud models was very unstable because of the low roll moment of inertia—in the case of the latter configuration, the model was only a little longer than wide. NASA experience showed that roll and pitch oscillations could be completely stabilized using artificial damping. McKinney noted.

In forward flight, drag of shrouded rotor-propellers normally would require considerable nose-down tilt to establish fore-and-aft balance of forces—a rule-of-thumb provided by McKinney is approximately one degree forward tilt for each mile-per-hour of speed. A series of movable vanes could be used to turn the thrust backward, forward force on the vanes acting to offset shroud drag, McKinney stated.



COCKPIT of Piasecki VZ-8P has flight controls resembling conventional helicopter. Collective pitch lever is on the left side.

Nose-up pitching, caused by action of the forward rotor-propeller downwash on the rear unit of shrouded configuration, would be aggravated by use of turning vanes beneath the shroud to reduce nose-down tilt, unless they were fitted under the front shroud only. Also, an unstable pitching moment would result from center of thrust moving markedly ahead of center of gravity due to angle of attack needed for forward flight.

Dynamic Stability

Dynamic stability investigation, although limited, showed that unstable rolling oscillation evident in hovering flight increased in forward flight. This was noted that as the airspeed of the model increased, the model became unstable with the same amount of artificial roll damping that had stabilized it in hovering flight. It was possible to cure this by increasing the artificial damping.

Hovering control of a four rotor-propeller configuration can be fairly simple and straightforward, McKinney reported, with pitch and roll control obtained by varying thrust at opposite ends or opposite sides; yaw control could be provided by means of a simple control vane beneath the rotor-props or by varying total pitch to provide net change in torque.

A two rotor-prop configuration would be more complex to control in hovering, McKinney noted. Suitable roll control can be produced by cyclic variation of blade angle of non-articulated rotor-

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props to produce more thrust on one side of the disk than on the other. Spoilers or drag devices would not provide a corresponding increase in thrust on the opposite side, so are not considered satisfactory, he continued. Exhaust thrust is insufficient to provide sufficient power to give the required moment and a vane under the propellers would have to extend so far beneath the machine as to spoil the primary advantage of its low silhouette.

Lateral Control

Forward flight control experiments indicate that any lateral control system satisfactory for hovering flight would also be suitable in forward flight. Additional requirements would be placed on the longitudinal control system to handle the large nose-up pitching moments encountered, he noted.

Large change in trim would make it difficult to provide sufficient control to stabilize the nose-up pitching condition with a single stick control without having excessive control sensitivity for hovering flight, McKinney indicated. A thumb switch on the stick would be, at best, a clumsy, coarse additional control, he said. Turning vanes, under the front shroud only, could reduce need for an overly sensitive control and obviate need for a thumb switch if they were linked to move in conjunction with pitch control. It might be desirable to have nonlinear variation of vane deflection with stick deflection so that stick movements near center, required for hovering flight, would not cause excessive linear accelerations because of vane deflection.

In the Chrysler vehicle, since the decision had been made to use simple rigid rotor-propellers and thus use of conventional collective and cyclic pitch were ruled out, a system of louvers upstream of the rotors was developed to provide both trim about the pitch axis and a broad band of control above and below the trim curve. To provide trim and roll control about the roll axis, a system of roll vanes is located downstream of the rotor in the duct outlet. Yaw control is obtained by means of a single vane in each duct, also downstream of the rotor.

Stick Movements

Fore and aft movement of the stick activates the pitch louvers in the duct inlet to provide nose-up and nose-down movements; lateral displacement of the stick produces movements in the roll vanes in the duct outlets; foot pedals activate the yaw vanes. Cascades located in the outlet of the front duct only deflect the slip-stream rearward to produce propulsive force.

Ducts were experimentally developed in the wind tunnel, starting with a large inlet lip radius and reducing it step by

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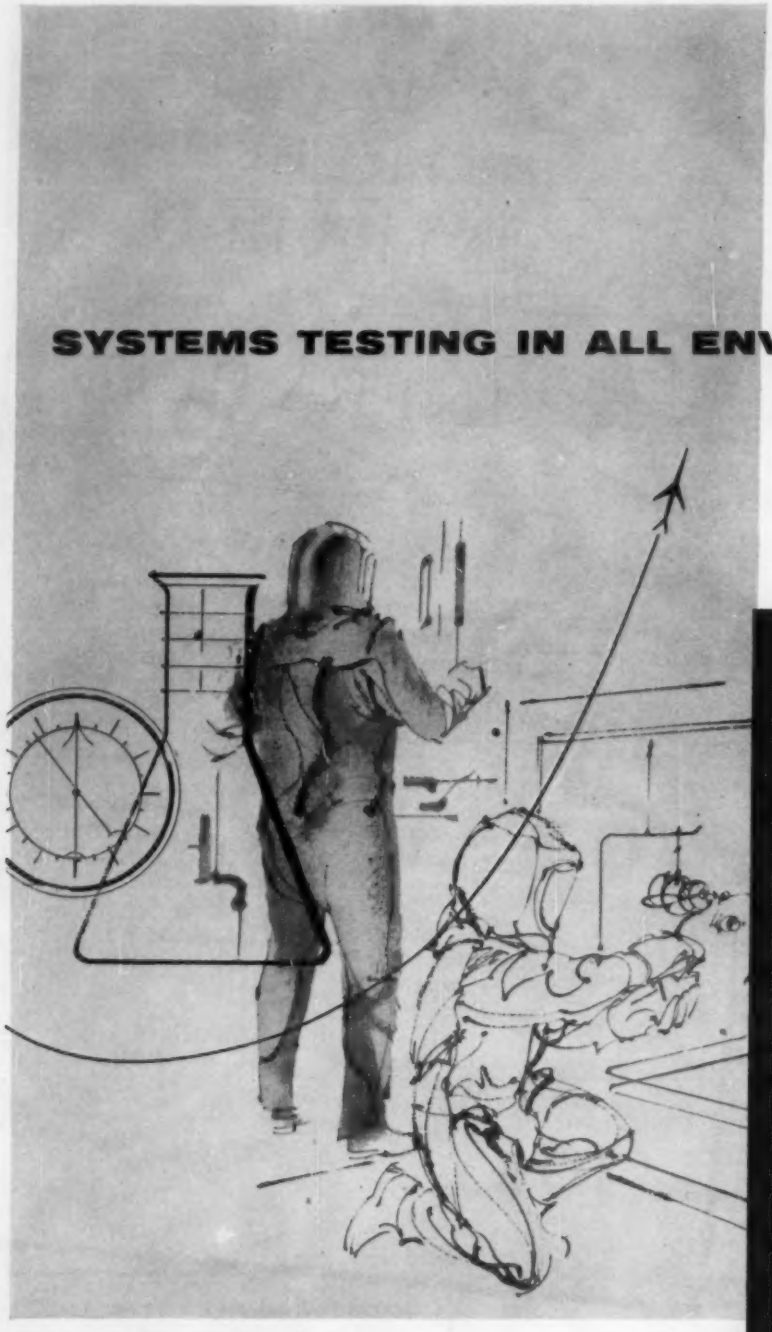

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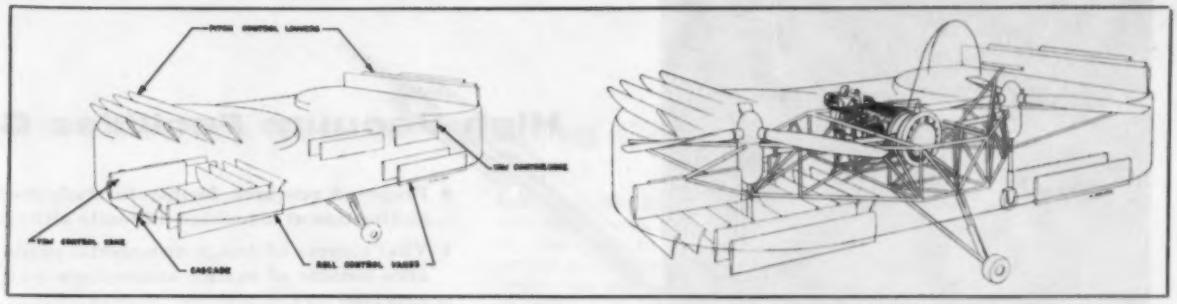


CHRYSLER system of cascades, under front duct only, provides slipstream deflection to increase propulsive force and overcome drag.

step, Chrysler defense operations project engineer John V. Gorton reported. It was noted that as inlet radius of the duct was decreased, nose-up pitching was lessened, as was thrust augmentation. Final design is aimed at optimizing these factors. Conventional three-blade propellers were tested in a full-scale static test bed. Twist distribution of the blades was varied by physically twisting them in a hydraulic fixture until optimum thrust per horsepower was realized. Blades in the Chrysler test bed are 8.5 ft. diameter.

Chrysler flight test bed is approximately 23 ft. long, 10 ft. wide and 4.5 ft. high. Gross weight, including pilot, fuel and test instrumentation will be 2,000 lb.

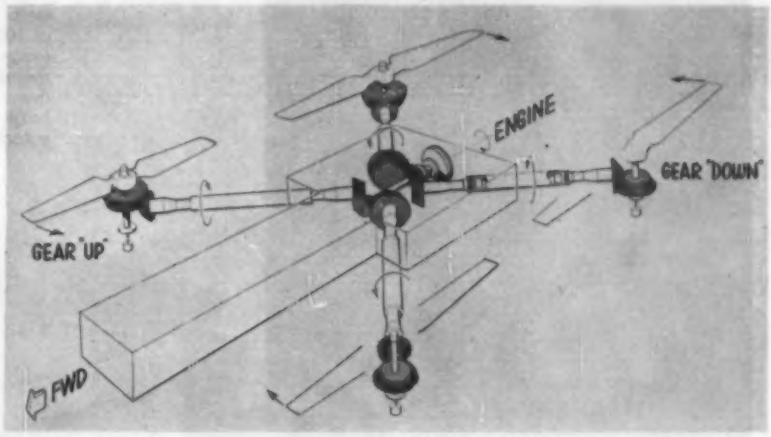
Powerplant is a six-cylinder Lycoming with takeoff rating of 380 hp. at 3,400 rpm. and continuous rating of 360 hp. at 3,200 rpm. Two modifications made to the engine are removal of the normal reduction gear box and installation of a gear box that transmits power through extension shafts to the front and rear rotorprops. Engine also powers a cooling fan.

At each propeller is a reduction gear of approximately 2:1 ratio to provide some 1,550 rpm. to the propeller shaft, and also counter-rotation of the props. The drive line system has no clutches.

Tubular Airframe

Airframe is all-welded alloy steel tubular structure, the central portion being a box frame supporting engine, pilot and main landing gear. Fore and aft trusses support front and rear propellers and ducts. Two main oleo struts of the landing gear are on either side of the center section and two secondary struts, beneath the propeller gear boxes, have full castering wheels.

Flight duration will be approximately 30 min. Program currently calls for 50 hr. of tiedown and hovering testing prior to free flight trials. Four-rotor configuration was chosen for Aerophysics VZ-7AP because its relatively large disk area promised good ratio of weight lifted to power produced, also because of the possibility of controlling large pitch and rolling mo-



AEROPHYSICS rotor system provides differential propeller pitch (above); hub detail (below).

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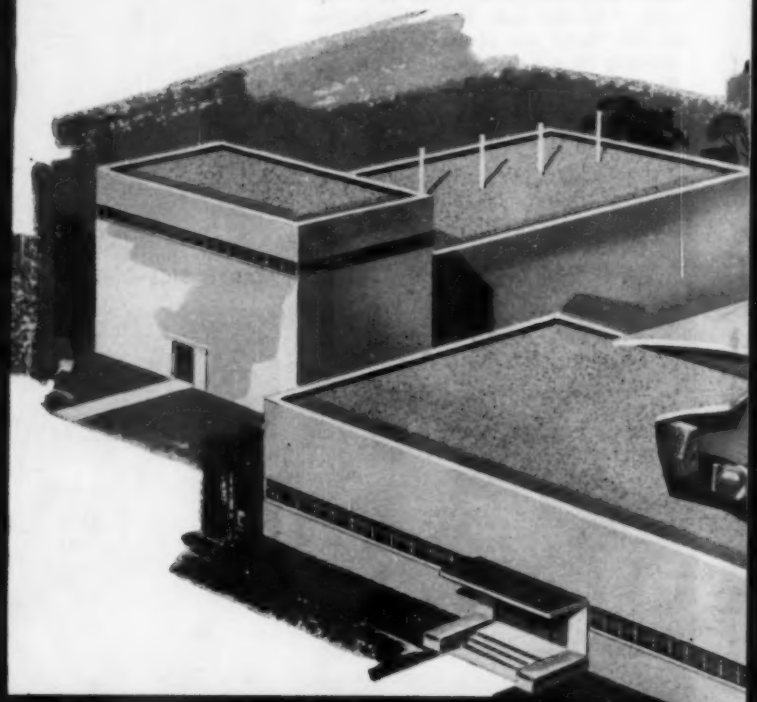

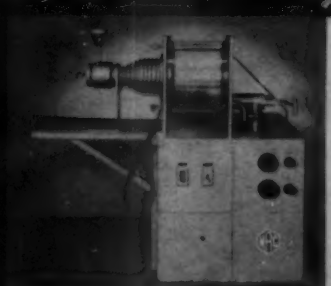

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Call or write us today for a preliminary exploration of how we can help you develop better materials and components for more reliable performance in space vehicles.

Rocket Research In the advanced planning stages, this facility would provide 33 billion cubic feet per minute vacuum pumping capacity to maintain a pressure of 10^{-6} mm mercury during test. Chamber approximately 12' diameter x 200' long.

National Research Corporation

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NRC

Missile Instruments — New 2-oz. NRC ALPHATRON® Densitometer measures atmospheric density up to 250,000 feet. Pulsed output can be telemetered.

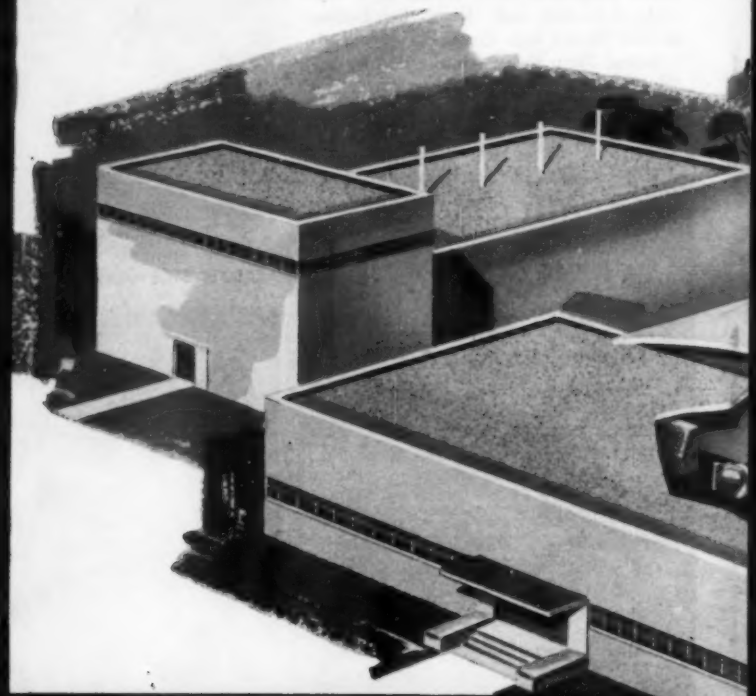
A Complete Line of vacuum arc, induction and resistance furnaces and components is available to help you develop or produce new high performance metals. Design of this equipment is backed by the extensive experience of NRC's vacuum metallurgy research department.

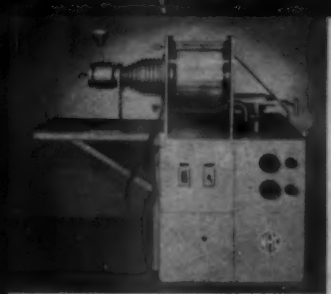
Large Pump Cuts Costs — New 32" NRC vacuum diffusion pump has a capacity of 50,000 cubic feet per minute. These pumps have the capacity needed to maintain a vacuum of 10^{-6} mm of mercury under dynamic operating conditions. Standard sizes as small as 1" available.

High Vacuum Facilities Can

- **Proposed research facility to study rocket combustion at simulated 100-mile altitude**
- **Vital secrets of design or material performance outside of earth's atmosphere may be revealed**

Many products or materials behave differently even before reaching the high vacuum environment of 100-mile altitude. Lithium, zinc and other metals evaporate. Plastics properties change. Metal-to-metal contacts may bind. Conventional lubricants don't work. Rocket flame patterns change — may burn away control surfaces. Changing surface characteristics influence emissivity — affect heat balance.





Test Materials or Components—Laboratory test facility having more than 5,000 cu. in. test space is capable of vacuums as low as 10^{-8} mm of mercury, or approximately 300-mile altitude.

Ultra-High Vacuum Investigations — A continuing, integrated research effort is maintained to seek new techniques for producing ultra-high vacuums. Laboratory systems in both our Cambridge and Newton plants are operating continuously at or below 10^{-11} mm of mercury.

Revolutionize Missile Testing Concepts . . .

Be sure your product will work by testing it in simulated *extreme* altitude conditions. Simulated tests at altitudes up to 20 miles, for example, do not necessarily provide evidence of extreme altitude performance.

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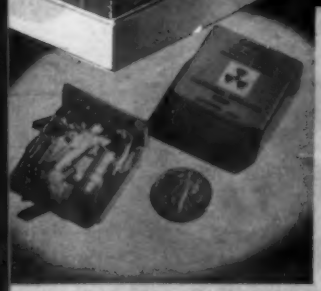
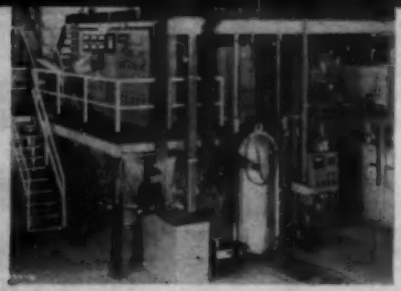
NRC



Missile Instruments — New 2-oz. NRC ALPHATRON® Densitometer measures atmospheric density up to 250,000 feet. Pulsed output can be telemetered.



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Pins shown actual size

...to serve 'most every connector need!

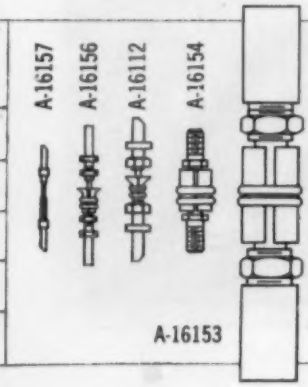
Virtually any size, capacity and configuration of electrical connector, with any number of contacts . . . from miniaturized 7.5 ampere to 300 ampere connectors can now be made utilizing the new Cole self-aligning Contact Pins. Relatively simple tooling methods make it possible to produce even a small number efficiently.

The basic reason why the Cole Connector succeeds where others fail lies in the unique ball and socket principle of these self-aligning contact pins. They are flexible, not rigid as in conventional connectors — therefore always function easily, dependably despite possible misalignment due to rough handling, high-shock or vibration. They require far less pressure to open and close, are completely reliable under aircraft and guided missile environmental conditions.

SPECIFY YOUR OWN CONNECTOR

The chart below gives you the necessary data for specifying custom Cole Connectors for your particular requirements. Write us outlining the purpose for which they will be used, number of contacts, capacity, size, configuration and mounting requirements. We can then engineer a Connector to meet these precise specifications and build a prototype at low cost for your approval.

*Patent applied for



NO.	CURRENT @ 65° C RISE	CENTER LINE SPACING MISC.	LENGTH OF CONNECTOR PINS & SOCKETS—MIN.
A-16157	7.5 amp.	7/32"	1¼"
A-16156	15 amp.	7/32"	1⅜"
A-16112	30 amp.	5/16"	1⅜"
A-16154	75 amp.	5/16"	1¼"
A-16153	300 amp.	1"	4"

Cole
ELECTRIC CO.
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Culver City, Calif.
TE 0-4701

ments by adjusting the rotor thrusts.

Initially the design considered the use of shrouded rotors, but considering the drag, required large tilt angles or use of vanes, it was decided to delete the shrouds and use only rudimentary rings around each rotor-prop which increased propeller diameter, gave lower disk loading. Rings appear to provide a 4% gain in hovering thrust.

Concurrently it was considered necessary to provide flapping and drag hinges on the blades, Aerophysics project engineer Robert W. Evans reported. He notes that following flight tests, during which control without ducts has been demonstrated, the company may investigate performance gains to be obtained by installing them.

Rolling Moments

Aerophysics expects that due to rotation of the right and left propellers in opposite directions and phasing of the rotors, the rolling moments will be canceled out in normal forward flight. Pitching moments are additive, Evans notes, and require application of increasing thrust to aft propellers as the platform goes from hovering to forward flight.

Artificial stability augmentation has been developed because an analytical study indicated that the VZ-7AP would be difficult to control due to a divergence in pitch and roll having a period of about five seconds. Stability augmentor is being built to Aerophysics specifications by Kearfott, Inc.

Pitch and roll control by the pilot is by moving the control stick forwards, aft and sideways, differentially controlling the pitches of the four propellers; yaw control is by means of foot pedals which control a rudder in the exhaust system of the 425-shp. Turbomeca Artouste II turbine. Collective and differential pitch controls are linked. The control cable on each propeller hub operates a hydraulic servo system which changes the pitch of two propeller blades equally.

Transmission system from the engine takes 6,000 rpm. and distributes it to the propellers which turn at 2,150 rpm. Transmission was designed in cooperation with Sargent Engineering Co. Central gear box has an input shaft carrying two spiral bevel gears, each driving two intermediate shafts. These shafts lead diagonally to the four rotor-prop gear boxes, where right-angle spiral bevel gear drives are used. Shafts between turbine, main and propeller gear boxes have spur-gear type universal couplings.

VZ-7AP will be approximately 17 ft. long by 16 ft. wide; the cargo floor is 41 in. from the ground and measures 4 ft. x 4 ft. Vehicle has a dry weight of approximately 1,700 lb. and can carry a useful load of about 555 lb., Evans

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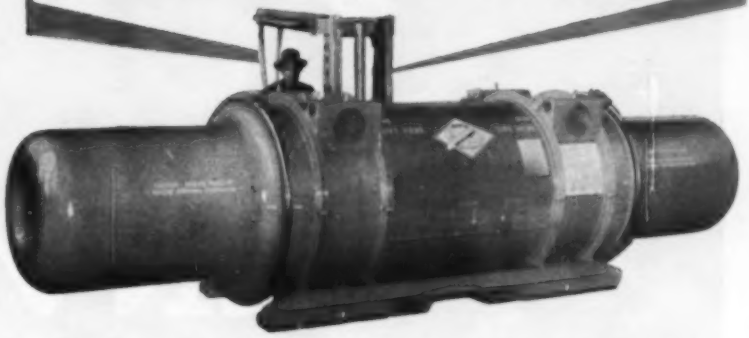
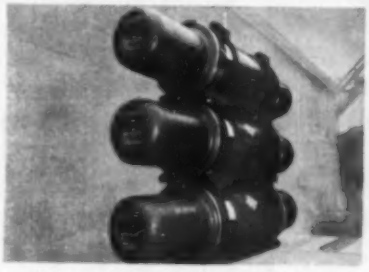
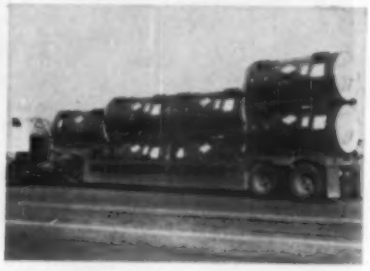
in-flight refueling stores, missiles and rockets, jet engines...accessories
60% LIGHTER IN WEIGHT!



HARCO CONTAINERS ARE THE *ONLY*
fiberglass containers approved by BuAer for handling in-flight refueling stores. Far lighter in weight than steel containers, they also transport the Harco developed ground handling trailer for moving of stores from container to aircraft. Type 1500 Harco Container is 18½-feet long, 4½-feet diameter. Unique design of end sections permits reversing and telescoping into center section for empty-return shipment, reducing length to less than 10-feet.



Harco Containers can be stacked three high for conservation of storage space; provision is made for sling or fork-lift-truck handling.



Note end sections reversed for empty shipment. Seven Harco containers with their integral ground handling trailers can be shipped in the same space required for three conventional containers.

write for literature and quotations on your container and ground handling equipment requirements.

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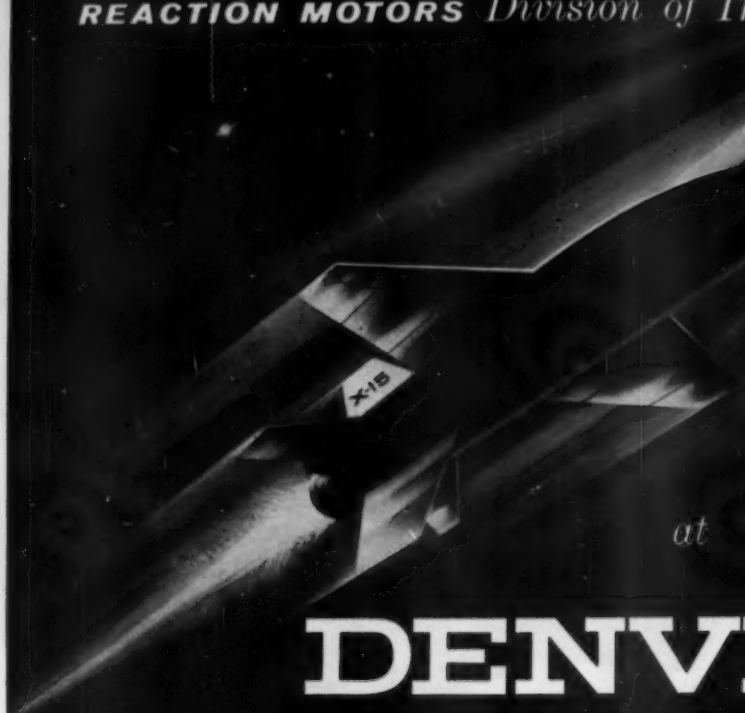
REACTION MOTORS *Division of Thiokol*



at

DENVILLE

New Jersey

Reaction Motors—America's first rocket company and an outstanding pioneer in the field of liquid propellant rocket engines—now, a part of Thiokol Chemical Corporation, is contributing important advances in rocket engineering. Developing power plants for the Air Force's X-15 manned rocket plant is one of the current projects. With the addition of Reaction Motors Division's experienced personnel and modern facilities, Thiokol has expanded its leadership in the design, development and production of rocket propulsion systems to both solid and liquid rocket engines.

Engineers, scientists—perhaps there's a place for you in Thiokol's expanding organization. Our new projects present challenging problems and the chance for greater responsibility.

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Travois X-2 Features Coaxial Ducts

Flying platform proposal to U. S. Army features use of coaxial ducts for optimum fairing. Specifications call for use of 245-hp. Franklin engine turning a large rotor of 10-ft. diameter and smaller rotor of 7-ft diameter. Control system considers fore-and-aft wheel movement to change pitch of large blades differentially in a cyclic manner, rotation of wheel would cause large blades to change pitch cyclically for roll while simultaneously applying friction to brakes on small and large rotor shafts for yaw. Designer of Travois X-2 is Leonard E. Mueller, Eau Claire, Wis., who reports that he has made successful flights of models of the configuration. Scale model, above, places two men fore and two aft.

said. He estimated that with less conservative design, useful loads can be increased to some 1,600 lb.

Airframe structure is comprised of sandwich panels having clad aluminum faces bonded to aluminum honeycomb cores. Panels are riveted to longitudinal and transverse spar caps machined from commercial aluminum alloy extrusions. It is expected that the honeycomb core will absorb some of the inherent vibration.

Two blade rotor-propellers can be positioned fore and aft and a portion of the guard rings are folded to provide minimum width for transportability.

Piasecki VZ-8P platform employs three-blade rigid rotor propellers employing cyclic pitch to provide a moment independent of center of gravity. Controls are conventional: collective pitch lever with "motorcycle" throttle grip, stick for longitudinal and lateral control and rudder pedals for directional control.

Designer's Report

Designer Frank N. Piasecki's report provided little data regarding the system of transverse and inboard stators in each duct; the company is maintaining tight control of information regarding its tandem duct test bed, although it already has some 25 hr. operating time, including brief free flight trials.

Powerplants are two Lycoming 0-360 four-cylinder engines fitted with superchargers. Engines are located between the rotorprops, one engine below the pilot, the other displaced to the left to balance the pilot's weight.

Rotor ducts are built up of aluminum alloy akins and stiffeners, a ring at the plane of the rotorprops providing maximum stiffness to maintain the tight rotor clearance. Primary fuselage structure consists of two outside longitudinal beams and two intermediate beams, three transverse bulkheads connecting the longitudinal beams.

Drive System

Drive system consists of components connecting the engines, placed transverse in the fuselage, into a central transmission and then to the rotorprops. Design provides for both engines being capable of driving the entire system in event of engine failure.

Engines are started individually since this system does not require need for locking out the over-running clutch, which would be required for a single starter system.

Central transmission consists of spiral bevel gears in a cast magnesium housing. Rotor shaft passes through the transmission and carries one gear. Engine shafts each have a gear meshing with the gear on the shaft to the rotorprops. There are only seven main driving gears in the VZ-8P, Piasecki noted.

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with segregated circuits individually shielded, and with over-all shielding or with special shielding and jacketing.

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Suitable for operating temperatures up to 650° F. with nickel-clad copper conductor and laminated insulation having superior dielectric strength and moisture resistance. In AWG sizes 22 thru 4/0. In accordance with MIL-C-25038.

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High Temperature and Moisture Resistant Electrical Cable. Lewis "EXFLEX" Cable, single and multi-conductor, superior for circuits on hinged or pivoted parts. Resistant to abrasion and temperatures to 500° F.

* TEFLON is a Du Pont product

The LEWIS ENGINEERING CO.
Naugatuck, Connecticut
WIRE DIVISION

Johns-Manville announces new **MIN-KLAD** Insulation!

This one new product answers 4 basic thermal and mechanical requirements
low conductivity
high heat capacity plus erosion resistance
high strength
Asbestos-reinforced plastic
Min-K insulation

New Min-Klad insulation is engineered and molded to your design requirements.

Combines the capabilities of asbestos-reinforced plastic with the dramatically low conductivity of MIN-K insulation!

New Min-Klad insulation may well be the most significant advance ever made in missile and rocket insulation.

Developed by Johns-Manville research scientists, Min-Klad is the only product of its kind, a permanent lamination of the missile industry's two most effective high-temperature materials: 1) reinforced plastic and 2) J-M's recently developed Min-K insulation.

Does more than plastic alone

Min-Klad gives the missile designer all the advantages of high-temperature plastic: Strength, toughness, rigidity! Erosion resistance! High heat capacity! Yet Min-Klad does more.

It also insulates . . . and with dramatic effectiveness! Its insulating element is J-M's Min-K, an insulation with thermal conductivity that is lower than any other known insulation. Actually lower than the molecular conductivity of still air. And this conductivity (already less than half that of the best fibrous insulations) drops still further with altitude. At 10 miles, for example, it is decreased by as much as 40%, with further decreases at greater altitudes.

Wide range of applications

Min-Klad offers the missile and rocket designer a rich choice of heat-control possibilities. It may be used for a part that must insulate, yet have the structural advantages of plastic. Where requirements call for a scuff- and erosion-resistant insulating surface . . . or for a good adhesive bond between Min-K insulation and other surfaces. Or, it may be used to control high transient temperatures! For high heat capacity of asbestos-reinforced plastic combined with the low conductivity and heat capacity of Min-K result in a product that provides minimum heat transfer under transient conditions.

Min-Klad is now being tested for approximately two dozen missile and rocket designs. Why not investigate this new material for your present thermal requirements? Upon request, we'll be pleased to send you a sample of the material along with detailed technical information. Write Johns-Manville, Box 14, New York 16, New York. (Ask, too, for information on Min-K insulation and the new aviation insulation brochure IN-185A.) In Canada: Port Credit, Ontario.

JOHNS-MANVILLE JM PRODUCTS

USS GRAYBACK (SSG 574) simulates Chance Vought Regulus I launching technique during maneuvers off San Diego, Calif.

Grayback Simulates Missile Launching

By William S. Reed

Aboard USS Grayback—U. S. Navy demonstrated its nuclear weapon delivery capability during run-through of Chance Vought Regulus I missile launching technique during maneuvers off San Diego recently.

The submarine Grayback put to sea and after a short run submerged to 150 ft., then surfaced to run through a simulated launching of winged air-breathing type missiles.

Commissioned March, 1958 (AW June 23, p. 63), Grayback is the Navy's latest undersea craft built especially for launching Regulus I and II missiles. Converted submarines can handle only Regulus I. Grayback is 322 ft. long and displaces 3,800 tons submerged, roughly half again as large as earlier submarines.

Nuclear Submarine

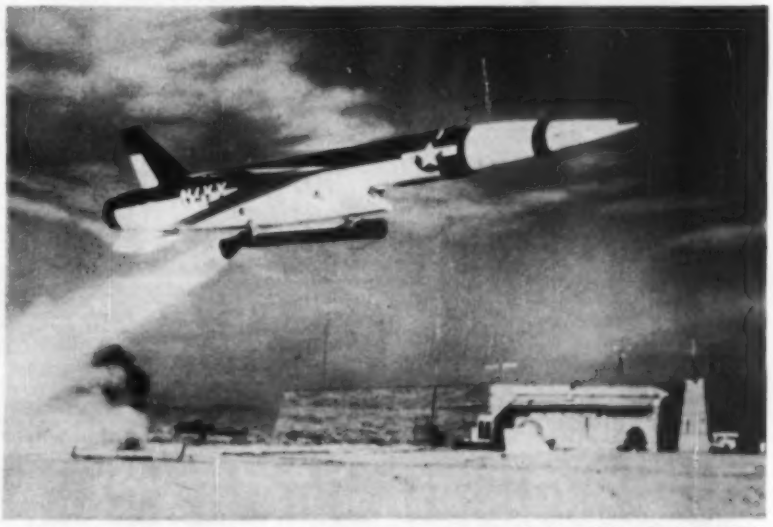
Plans call for a nuclear-powered submarine with the Grayback's missile launching capability. The Navy has on hand about 200 Regulus Is and 70 Regulus IIs, with no more planned to be delivered. The Budget Bureau has cut off funds for some air-breathing type missiles during Fiscal 1960. Grayback and other submarines designed for this capability will be converted for some other type of missile, probably Subroc when the Regulus supply is exhausted.

The most prominent feature of the submarine is two large hangars on the forward deck which house either four Regulus I or two Regulus II missiles. Hangars are part of the pressure hull and are accessible to the crew while the vessel is submerged.

Typical firing sequence (AW Oct. 6, p. 89) is as follows:

• **Target and launch point** are selected. Range and azimuth are set into the missile prior to surfacing. Range for the high subsonic Regulus I is 500 mi., in excess of 1,000 mi. for the Mach 2 Regulus II.

• **Submarine surfaces.** Hangar door is opened and missile is "rammed out" of hangar tail first. Simultaneously with Regulus missile fueling on the submarine deck, the launcher is positioning



REGULUS II with new ventral fin for directional accuracy is fired at Edwards AFB, Calif.

missile for proper elevation and azimuth. At same time, rudder is affixed and wings are unfolded.

• **Booster bottles** are attached, engine is started, and final checkout is made of systems.

• **Missile fires,** hangar door closes and the submarine dives.

According to the skipper, Lt. Cmdr. H. G. Nott, the entire sequence, from surfacing until Grayback dives, takes about seven minutes.

Grayback also carries a complement of the Navy's latest torpedoes and possesses the same attack capability as other submarines.

Other submarines under construction to handle Regulus-type missiles will have the Nautilus-type inertial navigation system so that launching position errors will be minimized.

Now, Grayback must come to periscope depth for a sun or star shot or rely on dead reckoning. Any error in launching position will result in corresponding target error.

Satellite Launch Cost to Be Cut

By Michael Yaffee

New York—At the present time and and under the best conditions, the going price of satellite launching vehicles is at least $10,000 per pound of payload delivered into orbit. But the price is coming down.

Planning of future U. S. space research is now being based on anticipated vehicle delivery costs as low as $300 per pound of payload in orbit.

A major factor in this cost reduction will be the modification and more efficient use of large missile boosters. Straightforward engineering changes, it is believed, will give an intermediate range ballistic missile an orbital payload potential of more than a ton and an intercontinental ballistic missile, an orbital payload capability of four to five tons.

In a speech to the International Society of Aviation Writers here, Dr. Homer J. Stewart, National Aeronautics and Space Administration's Director of Program Planning and Evaluation, estimated that it would cost $30 million at the present time for a launching vehicle such as that of Sputnik III which put a 3,000-lb. payload into orbit. This would be direct vehicle cost and is based on a figure of $10/lb. for an operational rocket launching vehicle and on a vehicle-to-payload ratio of 1,000:1.

These figures are somewhat on the optimistic side, as Dr. Stewart pointed out. While the Navy's (now NASA's) Vanguard is designed for a vehicle-to-payload ratio of 1,000:1 with a 21-lb. satellite, the vehicle has realized only a 6,000:1 ratio so far with a 4-lb. satellite. In addition, the launching vehicle, which could not be described as an operational rocket system, cost more than the $10-$12/lb. for a vehicle that has already passed through considerable development.

In the case of U. S. satellites launched by operational or modified operational units, the vehicle-to-payload ratio so far has been over 1,000:1. The 18-lb. payload of the Explorer launched by a Jupiter C, for example, results in a ratio of about 3,000:1. In the case of the Atlas communications satellite, Dr. Stewart said, the ratio is about 1,600:1.

Cost Reduction

But by designing equipment specifically for space purposes, Dr. Stewart believes ratios of 40 to 1 should be readily attainable and 25 to 1 "consistent with our current state of knowledge." This would reduce payload delivery costs to possibly $300/lb., matching them more to the $100-$1,000/lb. costs of the electronic equipment which goes to make up the major portion of the payload. In addition, of course,

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there are and will be the operating costs of launching, tracking and data handling.

To Dr. Stewart, these calculations indicate two important factors: one, that an increase in space research will not require a proportional increase in spending; and two, that with suitable modifications, large boosters already developed for weapon systems have the capacity to put substantial payloads into space.

Principal Modifications

The principal modifications required are some strengthening of the structure, development of suitably sized upper stage rocket vehicles, and tailoring of guidance and communication equipment to suit the special needs of space missions. While the required changes are reasonably straightforward engineering problems, Dr. Taylor doesn't believe they can be accomplished overnight or even in a few months.

But when these changes are brought about, an IRBM should be able to orbit a payload of more than a ton and an ICBM, a four to five ton payload. This will leave the million-pound thrust engine now under development, said Dr. Stewart, free for the more difficult and complicated space research applications that are anticipated during the next decade.

AMC Contracts

Wright-Patterson AFB—Ohio: Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Kollsman Instruments Corp., Standard Coil Products Co., Inc., Elmhurst, N. Y., type ME-4 airspeed indicators for F-84F aircraft, (IFB 33-600-59-4), (PR MO-8-MAINT-1828), $55,674.

U. S. Gauge Division, American Machine & Metals, Inc., Sellersville, Pa., thrust indicators, type MR-2 for KC-135 aircraft, (IFB 33-600-58-303), (PR PW-9-05D-4028), $25,661.

U. S. Gauge Division, American Machine & Metals, Inc., Sellersville, Pa., transmitter, rate gyroscope, type TRU-2/A for use on F-105 and F-106 aircraft, (PR PE-9-05C-4022 and PE-9-05C-4040), $25,661.

R. C. Allen Aircraft Instrument Division, R. C. Allen Business Machines, Inc., Grand Rapids, Mich., transmitter, rate gyroscope, type TRU-2/A for use on F-105 and F-106 aircraft, (PR PE-9-05C-4022 and PE-9-05C-4040), $56,117.

Pioneer-Central Division, Bendix Aviation Corp., Davenport, Iowa, transmitter rate of flow, fuel, type MA-1, used on F-105D and E and F-106A and B aircraft, (IFB 33-600-59-13), (PR PE-9-05D-4071), $134,716.

Olympic Radio & Television Division, The Siegler Corp., Long Island City, N. Y., amplifier, type ME-1A for B-52G, C-133B, KC-135A, C-130B and T-33A aircraft, (PR PE-9-05A-4196 and MO-8-MAINT-1838), $130,688.

Westinghouse Electric Corp., Dayton, Ohio, power supplies, type PP-1815-A, 100 amp., 28 v.d.c., P/N 903 J-706-4, including data for SM-62A missile, (RFP PE-9-03C-4500), (PR PE-9-03C-4500), $55,287.

Sperry Gyroscope Co. Division, Sperry-Rand Corp., Great Neck, N. Y., flight director computer, type CPU-4/A for installation on F-105 and F-106 aircraft, (RFP PE-8-05C-4021 and 4029), (PR PE-9095C-4021 and PE-9-05C-4039), $578,500.

Montrose Division, Bendix Aviation Corp., South Montrose, Pa., transmitter type MH-5 for F-104C, F-105B, F-106A and B, B-52G and T-38A aircraft, (IFB 33-600-58-295), (PR PE-8-05D-3676), $224,687.

Electrosolids Corp., Panorama City, Calif., power supply, PP-1692-U, (silicon) 200 amp., 28 v.d.c., including data for C-133B aircraft, (IFB 33-600-59-27), (PR PE-9-03C-4072), $29,700.

The Goodyear Tire & Rubber Co., Akron, Ohio, wheels, brakes, spares and data for B-57 aircraft (RFP 00-9-03B-1815), (PR 00-8-03B-1815), $124,806.

The Goodyear Tire & Rubber Co., Akron, Ohio, wheels, brakes and data for 36x11 for F-105B aircraft, (PR PE-9-03B-4204), (PR PE-9-03B-4204), $93,730.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., indictor, altitude, vertical speed, type AAU-1/A; amplifier, altitude, vertical speed, for use on F-105 and F-106 aircraft, (PR PE-9-05C-4024 and PE-9-05C-4027), $2,313,924.

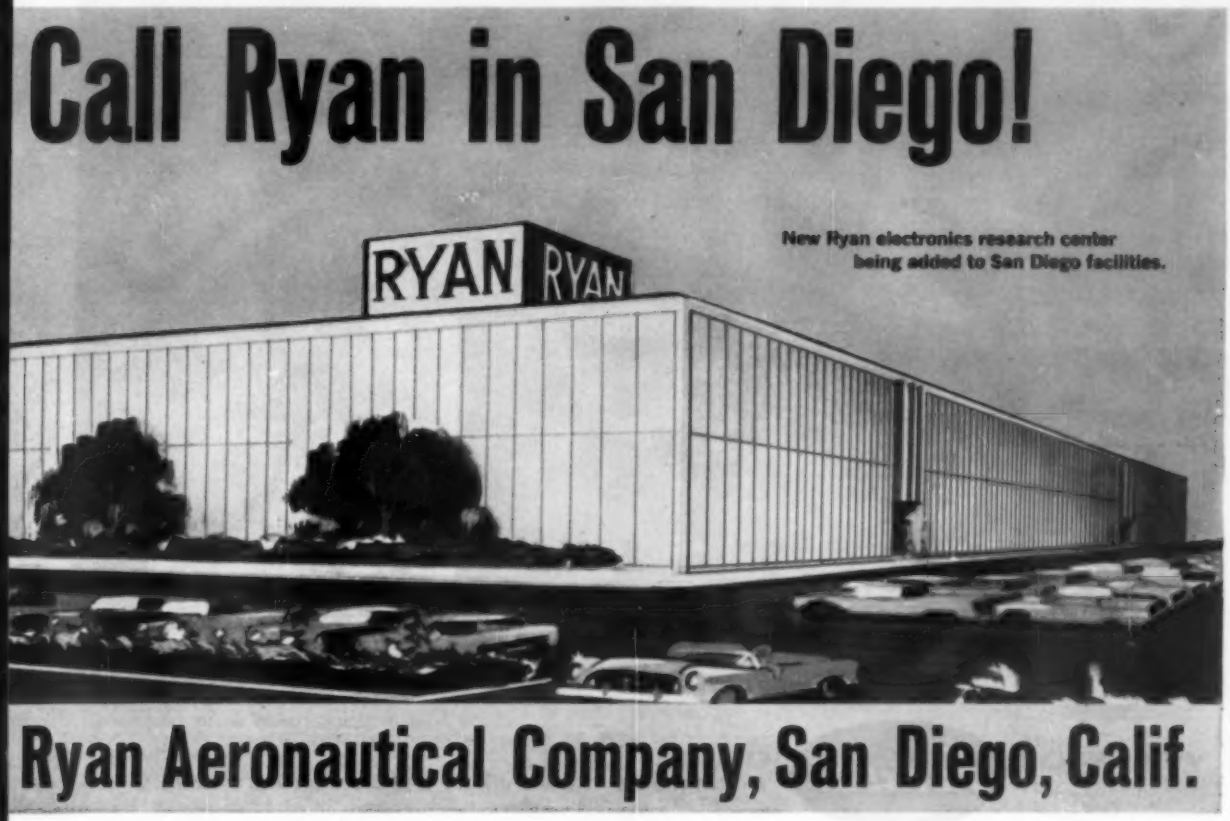
U. S. Gauge Division, American Machine & Metals, Inc., Sellersville, Pa., gage, pressure, manifold, type MS28018-1, for use on B-47, KB-50, KC-97 and C-119 aircraft, (RFP MA-9-05D-133), (PR MA-9-05D-133), $41,820.

Sundstrand Aviation Division, Sundstrand Machine Tool, Inc., Rockford, Ill., shafts and covers for support of the F-100 flying program, (RFP OC-6280), (PR OC-9-031-6280), $55,580.

Tung-Sol Electric, Inc., Newark, N. J., inverter assemblies, 6 va., single phase for support of the T-33A aircraft, (RFP SA-4794, SA-5763 and -1 and IFB-33-600-59-70), PR SA-8-03C-4794, SA-8-03C-5763 and SA-8-03C-5763-1), $31,210.

Hughes Aircraft Co., Culver City, Calif., aircraft and weapons controls systems, type MA-1, for F-106 aircraft, (RFP PE-8-11B-3395), (PR PE-8-11B-3395), $16,238,469.

Hughes Aircraft Co., Culver City, Calif.,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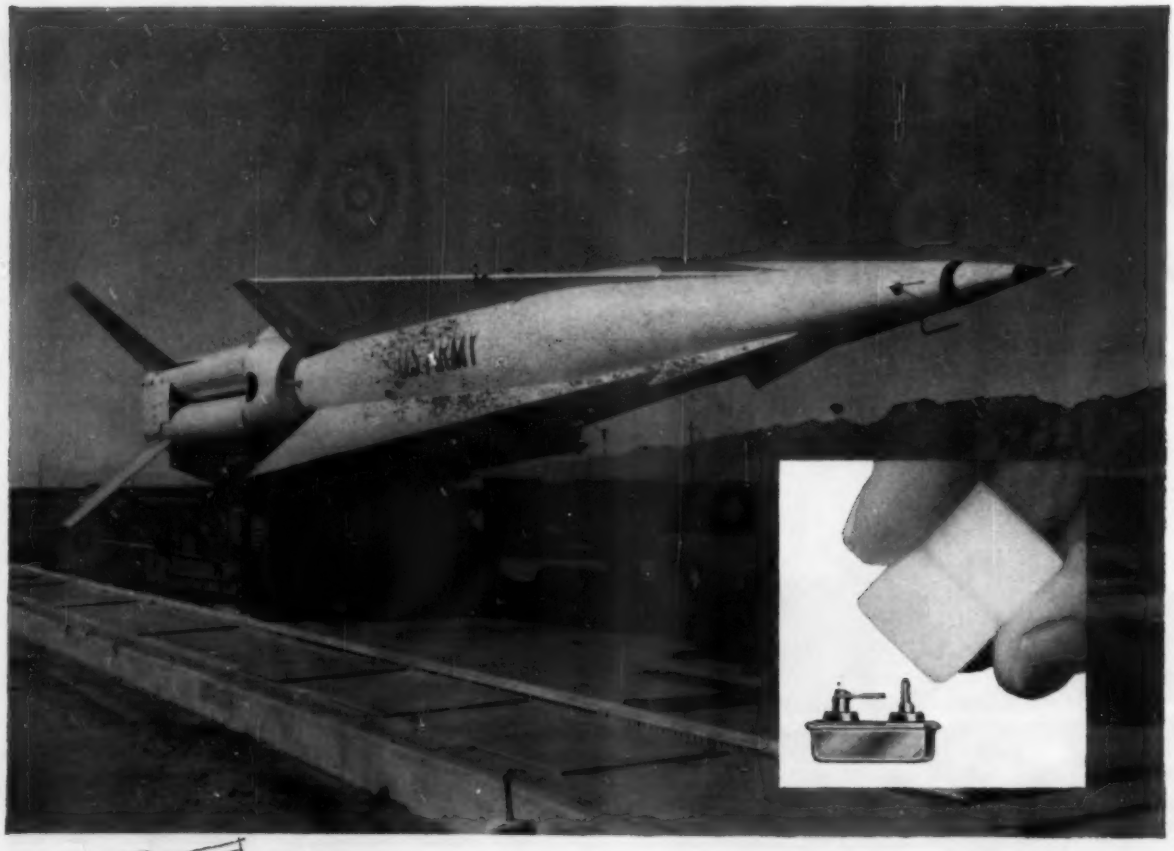

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replenishment spare component for E-series fire control system for F-86H aircraft, (PR WR-8-1270-441), $52,080.

Aeronautical Division, Minneapolis Honeywell Regulator Co., Minneapolis, Minn., gyros P/N JG 7044M-2 and gyros P/N JG 7044N-1, component of AN/AJB-5 labs., replenishment spares for F-100 series aircraft, (PR WR-8-FSC-1280-588), $407,775.

Eclipse-Pioneer Division, Bendix Aviation Corp., Teterboro, N. J., components of MB-7 automatic flight control system for C-133B aircraft (GFAC), (RFP PE-9-05F-4008), (PR PE-9-05F-4008 and amendments 1 and 2), $540,500.

Lycoming Division of Avco Corp., Stratford, Conn., services necessary to conduct the YT53-L-3 engine, Hamilton Standard model 53G51 propeller compatability for 0-1 aircraft program, (PR 20557 "Q"), $811,230.

The O. A. Sutton Corp., Wichita, Kan., fuel tanks, pylon, left and right hand, 275 gal. capacity, Type II, for installation on F-100 aircraft, (PR SM-8-03L-5035 and amendment 1), $2,080,611.

Specialized Propulsion and Control Equipment Corp., Garland, Texas, maintenance docks, type MB-3A for support of B-52 aircraft, (PR PM-8-X-5606), $299,444.

National Airlines, Miami, Fla., group A modification of contractor-owned DC-8 jet aircraft to CRAF configuration while in production, (PR PM-8-S-5653), $32,952.

Flight Enterprises, Inc., Windsor Locks, Conn., MATS-SAM of C-121 type aircraft, (PR SM-9-OIL-2007, PM-9-OIL-6039 and PM-9-S-6055), $1,052,870.

Text Film Department, McGraw-Hill Book Co., Inc., New York, 16 mm. black and white sound release prints of the series entitled "Office Supervisors Problems". EFP 33-600-59-5010), (PR EM-9-PP-6123), $39,375.

Ward LaFrance Truck Corp., Elmira, N. Y., basic maintenance data for items 1 and 2 under contract, (PR MP-623105), $47,573.

Ladish Co., Cudahy Wis., systematic study to determine what factors caused fluctuation in the mechanical properties of large steel forgings, (PR PB-8-MMP-6261), $59,846.

Avionic Division, John Oster Manufacturing Co., Racine, Wis., investigation, design, fabrication, of cruise control instrument system for turboprop aircraft, calibrators, test reports and technical management reports, (PR PE-8-S-3660), $112,393.

Sundstrand Aviation Division, Sundstrand Machine Tool Co., Rockford, Ill., drive, components, generator, constant speed, hydraulic, in accordance with Convair specification 8-02955, revision G and SCR-150 for the F-106 aircraft, consisting of the following components: transmission and gear box assemblies, gear boxes, shafts, covers, frequency and load controllers, (PR PE-9-03C-4063 and PE-03I-4064), $2,763,884.

Gordon Enterprises, North Hollywood, Calif., various items of photographic spare parts applicable to A-8B and A-8 magazines, D-4 body assembly, A-28 mount, and T-11, 0-23 and 0-15 cameras for aircraft, (PR-MO-8-6760-2593(C), -2606(C), -2534 (C), -2532(C), -2599(C), MO-8-6710-1002 (C), and MO-8-6720-1141(C)), $49,191.

Allison Division, General Motors Corp., Indianapolis, Ind., T56-A-7 turboprop engines for C-130B aircraft (USMC), (MIPR R58-781-142), $1,468,480.

Astrodyne, Inc., McGregor, Tex., igniters, for M15A1 JATO units, (PR 00-8-1340-1557), $91,723.

Small Aircraft Engine Department, General Electric Co., West Lynn, Mass., J85 engine reproduction and special tooling effort (CY 58), PR PE-8-02A-3818), $1,100,-000.

Bell & Howell Co., Chicago, KS-27A camera system, spare parts, special tools, test equipment and data therefore for reconnaissance missions for RF-105D and RF-105E aircraft, (IFB 33-6040-58-205), (PR PE-8-10D-3524, PE-9-10D-4013 and PE-9-10D-4062), $284,442.

Consolidated Diesel Electric Corp., Stamford, Conn., one vehicle, aircraft movement, unconventional, up to 500,000 lb. gross weight for B-52 aircraft, with supporting data, (RFQ 33-600-59-5002), (PR MP-9-2420-30105), $182,942.

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Satellite Reconnaissance Optics (Part II):

Satellite Optics Limited by Atmosphere

By James A. Fusca

Reconnaissance systems for viewing the earth's surface from satellites by means of image-detecting devices such as television, infrared, and photographic cameras are affected by three major optical problems: earth radiance, atmospheric optics, and optical resolution limits.

These problems are being considered separately in this series, this second article being concerned with atmospheric optics. The series is based on a study report, titled "Fundamental Considerations of Reconnaissance from a Satellite," prepared by the Space Reconnaissance Laboratory, Allen B. DuMont Laboratories, Clifton, N. J.

Clifton, N. J.—Atmospheric optics is the branch concerned with the quality of image formation through the atmosphere. Therefore, it describes one link of any optical communication system, another link being the imaging properties of the objective lens.

While atmospheric optics deals largely with the visual region of the spectrum, it also includes other regions susceptible to detection and imaging by optical devices.

The great majority of the information available on the subject of atmospheric optics concerns visual imaging properties between locations within the earth's atmosphere. Relatively little data is available on the problem of viewing the earth from above the atmosphere. Therefore, care must be used in applying previous data.

PHOTOGRAPH of the earth from an altitude of 100 mi. shows an area of 200,000 sq. mi. of the U. S. and Mexico. Dark area near the horizon is the Gulf of California. Picture was taken by a U. S. Navy camera mounted in a V-2 rocket fired from White Sands, N. M.

Ground Object Contrast

One of the most serious problems in the whole optical system is the fact that the atmosphere reduces the contrast of ground objects. Thus the earth appears as an object having low brightness modulation. This reduction in contrast is caused by a combination of two phenomena.

First is the veil of light caused by the illumination of the atmosphere by the sun. This would exist even if the earth were a perfect black body. It is, of course, the same blue sky seen from earth on a clear day. Second is the contrast attenuation due to scattering and absorption in the atmosphere. This phenomenon occurs irrespective of any illumination of the intervening atmosphere.

From the standpoint of communication system theory, contrast reduction in the optical image is immediately translated into a reduction in modulation of the electrical signal and thus becomes a signal-to-noise problem.

When a beam of light is incident on matter in the solid, liquid, or gaseous state, it is divided in only three ways. It can be absorbed (which constitutes it being converted to another form of energy), scattered (reflected in other directions), or transmitted (continued in the same direction).

Therefore, the sum of the absorption, scattering, and transmission must always total unity. The intensity of a beam of light in any medium can thus be specified from a knowledge of any two of three parameters.

• **Extinction coefficient.** In naturally occurring atmosphere both absorption and scattering operate simultaneously to attenuate the transmission. In many cases, either absorption or scattering may be negligible with respect to the other, but both processes exist and in general both are operating concurrently.

In practice, it is often difficult to measure them separately. In some cases it is not necessary to know their exact proportions. For these reasons, it is common practice to refer to the "extinction coefficient" of the atmosphere which is the total of the scattering and absorption coefficients.

In any optical medium, the brightness of an object seen against a black background is attenuated with distance. Bouger's law defines this relationship as the apparent brightness of an object at a stated range being equal to the intrinsic brightness of the object times the base e raised to the minus power of the extinction coefficient multiplied by the range.

• **Contrast attenuation.** The attenua-

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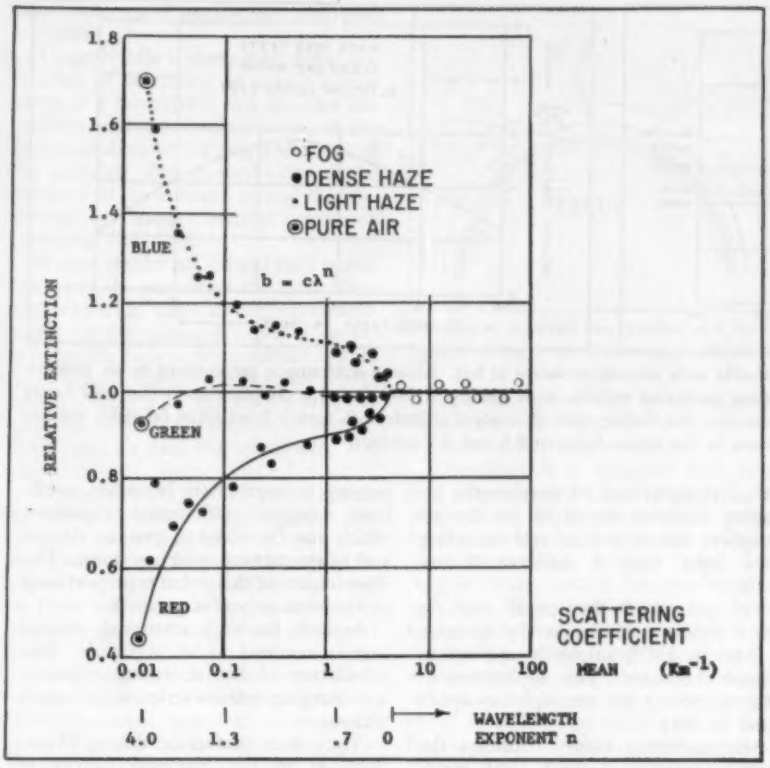

GRAPH of selectivity versus scattering coefficient. Coefficient scale is four-cycle logarithmic. Under it is shown the wavelength exponent at selected scattering coefficient values.

tion of brightness contrast can also be calculated from a knowledge of the scattering coefficient and range by means of Koschmeider's law which yields a perfectly general equation for the apparent brightness at a given range of a target of any brightness against a background of any brightness.

A quantity which finds wide use directly related to the scattering coefficient is the "meteorological range." This is defined as the distance at which the contrast of -1 is reduced to 2%, a value where detection is still definite if the object appears large enough.

The attenuation of visual and infrared radiation in the atmosphere results mainly from scattering by suspended particles and absorption by atmospheric gases, the two most important absorbents being water vapor and carbon dioxide with water vapor the more important of the two.

Attenuation Varies

The attenuation caused by scattering varies much more simply with wavelength than does the absorption by a given concentration of absorbent. Absorption occurs mainly in certain wavelength bands separated by windows of negligible absorption, while for natural haze scattering is a fairly continuous function of wavelength.

In a typical atmosphere, light attenuation in the visual and near-infrared region is caused almost entirely by scattering where in the infrared region severe absorption in certain bands is the more important reason for attenuation.

Atmospheric scattering is commonly referred to as haze. The various degrees of haze receive different names. At one end of the descriptive scale is fog. The foggier the atmosphere, the greater the scattering. Since fog appears white, the scattering is independent of wavelength.

At the other end of the scale is scattering on clear days which is very small but is quite dependent on wavelength, as evidenced by the blue of the sky.

• **Rayleigh scattering.** From earliest times there has been speculation about the blue of the sky. It was not until 1899 that Lord Rayleigh, observing that the sky is bluest when the air is purest, correctly referred the color to its actual cause, scattering of sunlight by the molecules of the permanent gases of which the air is composed. He demonstrated that an atmosphere containing nothing else scatters light in proportion to the inverse fourth power of the wavelength.

Such scattering is frequently called Rayleigh scattering. The mathematical investigation of the problem gave a

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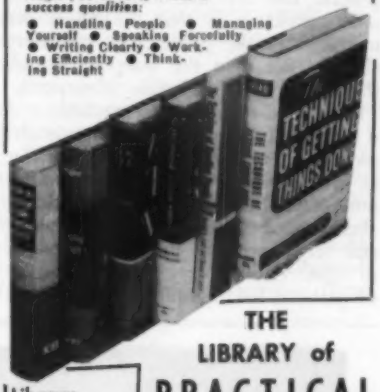

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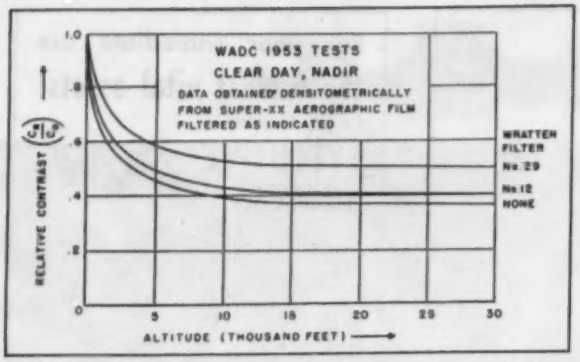

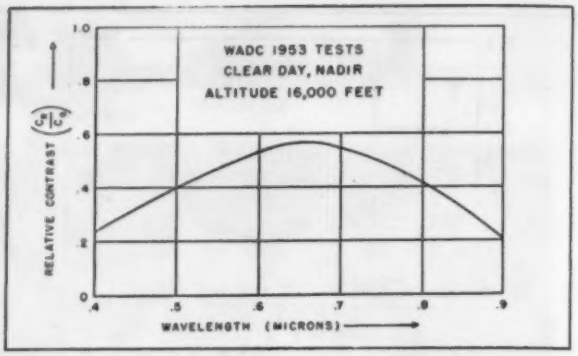

UNDER CLEAR conditions, scattering decreases steadily with altitude as shown at left. Because scattering is proportional to air pressure, for a given distribution of particle sizes the scattering coefficient reduces most quickly at low altitudes. Implication is that still longer wavelengths would further decrease contrast attenuation, but further tests at constant altitude with narrow band filters (at right) indicate that an optimum area was found for these conditions in the region between 0.6 and 0.7 microns.

general law for the scattering. The only restriction is that the linear dimensions of the particles be considerably smaller than the wavelength and that there be negligible absorption. This is valid for molecular particles.

• **Mie scattering.** It is a commonly observed fact that natural haze occurring at low altitudes is less selective than pure Rayleigh scattering. The Rayleigh theory applies only to particles of a size very much less than a wavelength of light. For the very important group of particles having radii between about 0.1 wavelengths and 10 wavelengths including most of the states of the atmosphere known as haze and including some light fogs, a different theory applies.

The successful theoretical work is based almost entirely on the research of Mie in 1908, originally applied to colloid chemistry. The application of Mie scattering to atmospheric optics came in 1931.

Mie scattering theory considers the electromagnetic waves of light inside and outside a small sphere and, after putting in appropriate boundary conditions, derives differential equations which may be solved to give the electric and magnetic vectors at any point. The illuminance at this point is proportional to the average vector product.

As with Rayleigh scattering, absorption is assumed to be negligible. The calculation of the scattering function, a converging infinite series, is extremely tedious.

They were performed during World War II at the National Bureau of Standards and are available for a useful

range of values of particle size and index refraction.

To apply Mie scattering to direct calculation of scattering in actual atmosphere is a formidable task because the problem becomes essentially one of statistical analysis of the size and index of the particles. The greatest value of the theory is to confirm and extend the usefulness of experimentally measured scattering functions.

Recent studies on natural haze occurring near the surface of the earth show that scattering varies as the wavelength raised to the minus 0.7 power in the wavelength region from about 0.4 to 12 microns. These experimental results are consistent with the known range of size and indices of refraction of natural haze particles and the computed Mie scattering.

The particles in typical smogs appear to be in the same size range as the particles in natural haze. Moreover, although smog particles are extremely diverse in nature, it is probable that most of them will have refractive indices of the same order of magnitude as natural haze.

Smog particles, like haze particles, absorb radiation as well as scatter it. The absorption, however, in the usual smog particle is probably not great enough to modify appreciably the extinction coefficient caused by scattering so that absorption and scattering may be treated independently in smogs not containing too much smoke.

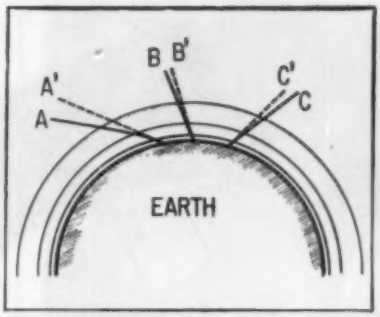

DIAGRAM indicates the bending of a ray of light resulting from astronomical refraction.

Therefore, it is expected that as a first approximation, scattering will be proportional to the wavelength raised to the minus 0.7 power for ordinary smog as well as natural haze. Los Angeles smog, which has smaller particle size than most smogs, has been found quite transparent to infrared in the 8 to 14 micron Langley window.

• **Non-selective scattering.** As the particle size becomes larger, the atmosphere is said to go from haze to fog. Fog can be defined as an atmosphere containing a large number of water droplets larger than several microns, while finer suspensions of water droplets can be defined as haze.

The Mie scattering theory makes clear that large particles being much larger than the wavelength of the radiation will scatter completely independent of wavelength; that is, be completely non-selective. Measurements show that there is a sudden change to non-selective scattering near the point where haze changes to fog, the point where hygroscopic nuclei may be supposed to start increasing in radius in an unstable manner.

The theoretical properties of scattering have been considered with the assumption that absorption is negligible. In actual atmospheres over considerable regions of the spectrum this is a correct assumption. Absorption is caused largely by water vapor which shows a relatively strong absorption in certain narrow wavelength bands separated by windows of relatively less absorption.

Presumably, the low and not the high absorption regions will be used for satellite reconnaissance.

When water droplet size is very small, scattering is much more important than absorption in determining the extinction coefficient. Assuming a droplet radius of 100 microns—a light fog—the scattering can be calculated from the Mie theory. Performing these

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calculations in the visual region shows that absorbed light is only 1/100,000 of the scattered light. Even for a raindrop of 0.5 cm., about the largest normally encountered, the absorbed light is only 1/200 of the scattered light. For this reason, absorption is usually considered to be negligible compared with scattering.

In the theory of optical communication through the atmosphere, a prime consideration is the attenuation of contrast. Especially where an attempt is made to optimize contrast by means of spectral filtering, a knowledge of the relationship between contrast and wavelength is necessary.

In treating contrast attenuation by atmospheric scattering, an expression that has been suggested frequently states that the scattering coefficient is equal to a proportionality constant times the wavelength in microns raised to the power of a wavelength exponent. In going from pure air to fog, this wavelength exponent would vary from −4 to 0.

Exponent Values

Measurements in extremely clear air have yielded a wavelength exponent value of −1.6 for visual ranges of 90 km. A recent study of haze conditions has given an exponent of −0.7, which appears to hold throughout the visual region and well into the infrared, from 0.4 to 14 microns. The −0.7 value also appears to apply to many types of industrial smog.

The relationship between the scattering coefficent and the wavelength exponent is shown in the accompanying graph. The wavelengths corresponding to the indicated colors average: blue 0.472 microns, green 0.547 microns, and red 0.647 microns.

Previously, atmospheric optics has been discussed from the standpoint of a uniform atmosphere. This permits the use of a convenient theoretical model and also describes the actual situation accurately for most problems involving optical image transmission in the horizontal direction.

In the case of satellite optical systems, transmission is never horizontal to the surface of the earth so it is necessary to consider slant range. Obviously, here the scattering conditions will usually vary markedly with altitude. For extremely clear blue-sky conditions the atmospheric scattering decreases steadily with increasing altitude. On the other hand, many typical weather conditions exhibit distinct stratification of the scattering, as evidenced by clouds or haze layer.

If the scattering changes with distance, the contrast attenuation can be calculated by considering the scattering as being caused by a uniform medium having the same integrated volume co-

Series 4103 Circular Pots, as shown above — are particularly suited to telemetering, control systems and computers. Furnished single or ganged up to 5 units. Life at least 1,000,000 cycles.

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efficient. Based on the most recent standard atmosphere tables, the optical thickness of the atmosphere is about 8 km.

Using this value the contrast attenuation for pure Rayleigh scattering for an object at ground level viewed directly downward by an observer above the atmosphere can be calculated, and the results of this calculation show that Rayleigh scattering in itself causes negligible attenuation for purely vertical viewing. Actually, however, measured values of contrast attenuation through the atmosphere are considerably greater.

Under clear conditions, scattering decreases steadily with altitude. Since scattering is proportional to air pressure, for a given distribution of particle sizes the scattering coefficient reduces most quickly at low altitudes. This relationship can be seen in the accompanying graph taken from tests conducted at Wright Air Development Center in 1953. The contrast was measured photographically and with the indicated Wratten filter on a clear day.

Three facts are of interest on this graph:

• **Use of a filter** passing only longer wavelengths, the Wratten 29, gave less attenuation than the unfiltered panchromatic case.

• **Air is sufficiently** thin at 30,000 ft. altitude (10 km.) that essentially all of the atmosphere lies below the observer. This is implied by the asymptotic nature of the curve at 30,000 ft. Actually, the contrast at 30,000 ft. was only 1% worse than at 20,000 ft. For all practical purposes, all of the atmosphere is contained below the relatively low altitude of 10 km. Considerable data is available on reconnaissance from these altitudes that can be applied directly to the satellite reconnaissance problem.

• **Scattering coefficient** at all wavelengths is about 10 times greater than that predicted by Rayleigh scattering.

It might be inferred from the data of this graph that employing longer wavelengths would still further decrease the contrast attenuation. Further data taken during these tests indicates that this is not necessarily the case. The related graph shows data taken at a constant altitude of 16,000 ft. where narrowband filters were employed. It can be seen that an optimum point was found in the 0.6 to 0.7 micron region.

Other tests, however, made at Cape Canaveral, Fla., show somewhat different results. Here measurements were made from the ground of an aircraft flying at 35,000 ft. on a very clear day when the ceiling was unlimited. The results show not only less attenuation than measured in the WADC tests but indicate least attenuation for the longer wavelengths.

Both tests, however, illustrate the fact that on clear days and looking directly downward (nadir viewing) that contrast attenuation may not be serious.

When all of the atmosphere lies between the observer and the target, the parameters of atmospheric attenuation are normally specified in units of one atmosphere thickness (for nadir viewing). For other obliquities, the number of atmospheres increases as the cosecant of the angle from the nadir. At 60 deg., for example, the contrast attenuation coefficient is doubled and for hazy conditions the contrast can change enormously over the full field of view.

Other Image Degradations

By far the most serious problem faced in atmospheric optics is attenuation of contrast. Several other types of image degradation, however, are due to the atmosphere. These are the atmospheric effects on distortion, turbulence, and resolution. Astronomers are familiar with all of these phenomena and considerable data is available.

In fact, analysis of this mass of data indicates that all of these aberrations are likely to be negligible in satellite-to-earth optical imaging devices, although they can be troublesome in earth-to-satellite viewing.

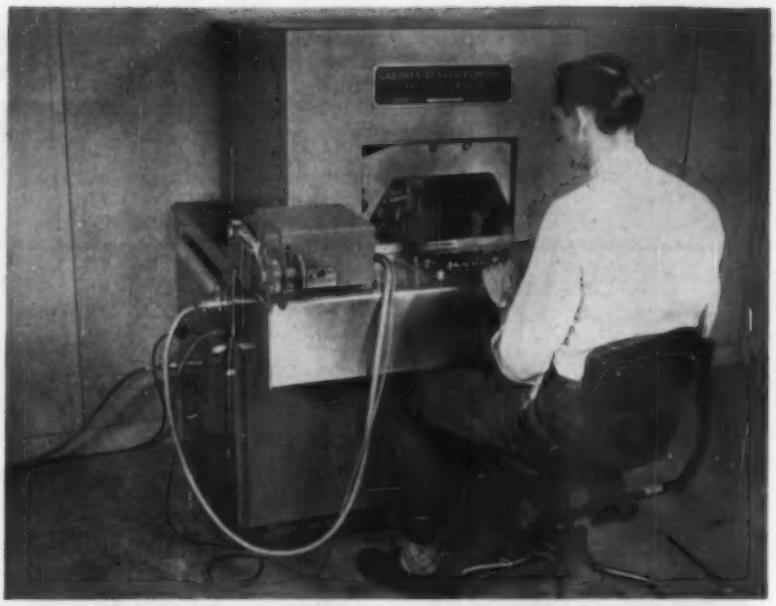
• **Distortion.** The fundamental law of optics is that a ray of light passing from a medium of one optical index into a medium of a different optical index undergoes a change in its direction. It is bent toward the normal when passing from a low index to a high index medium and vice versa.

The amount of bending of a ray depends on its distance from the zenith, being zero at the zenith and increasing to about 35 min. near the horizon. The ray of light begins to curve as it enters the atmosphere, the bending increasing fastest near the surface of the earth.

By definition, the index of a vacuum is one. Under standard atmospheric conditions at the surface of the earth, the index is 1.00027 for the visual region. For zenith distances of less than 60 deg. and under standard atmosphere conditions, this distance is equal to 57.3 times the tangent of the zenith angle. Tables listing answers at all zenith angles are given in astronomy texts.

• **Turbulence.** Turbulence or boiling is caused by minute variation in the index of refraction of the atmosphere, due chiefly to temperature changes along the optical path. Because of this variation in index, a single ray is deflected in a random manner and thus the target appears to move irregularly.

This phenomenon is most noticeable over long distances horizontal to the earth. It is much less for astronomical observations and is expected to be en-



Keller Develops Mechanized Wire Wrap

Automatic wire-wrap machine for making solderless connections, developed by Keller Tool Division of Gardner-Denver Co., operates from punched tape, punched cards or from manual keyboard for trial runs. First model, produced for Hughes Aircraft Co. use in assembly of its new ARC-68 HF communications set (AW Dec. 29, 1958, p. 58), can handle boards measuring up to 20 x 20 in., with terminals s ed as closely as 0.2 in. apart. Using AWG 24 solid conductor wire with 9 mil PVC insulation, machine automatically bends wire into "L" shape (if required), cuts it to size, strips insulation off both ends and wraps each end around appropriate terminal. Current models average six seconds per operation. Company's address: Grand Haven, Mich.

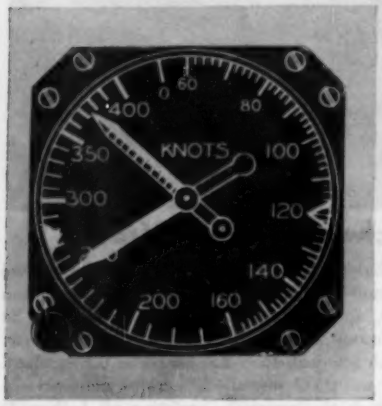
tirely negligible for satellite-to-earth observers.

• **Resolution.** Suggestions have been made that atmospheric scattering, entirely aside from the contrast attenuation, contributes to a blurring of the optical image. This supposed loss of resolution has acquired the name "the ground-glass effect."

The improbability of any marked effect has been discussed in several papers in the literature. While these papers contain many approximations, their main conclusion is that no loss of resolution occurs.

This has been confirmed by photographic measurements and by examination of targets in medium haze and dense fog by microphotometer means, with the conclusion that any such loss of resolution if it occurs is less than the resolving power of the best optical instruments.

Of the various atmospheric image degradations other than contrast attenuation, all appear to be completely unimportant in the particular problem of the imaging of earth targets by optics in a satellite. The only problem in atmospheric optics is simply contrast attenuation due to scattering and absorption.



AIRSPEED indicator for ADVISOR (left) has index and command markers. Striped needle shows limit airspeed. Per cent thrust gage (right) is used with air data computer. Pointer shows actual per cent thrust of engine while small index shows command thrust. Information is derived mainly from exhaust pressure ratio, ambient temperature and pressure.

Jet Aircraft Air Data Computer Will Be Installed in Convair 880

San Diego—Critical jet-age range, endurance, takeoff, climb and approach problems may be solved for pilots by a new air data computer without recourse to complicated performance charts.

ADVISOR, derived from ADVanced, Integrated, Safety and Optimizing computeR, and developed by John Oster Co., Racine, Wis., will be installed in the Convair 880 when the first flight is made in late January.

ADVISOR operation is predicated on known aircraft performance parameters into which are fed gross weight, fuel quantity, airspeed, ambient temperature and pressure, and engine performance.

Before the engines are started, gross weight and fuel quantity are set into the computer by the pilot as part of the preflight routine.

All other information is fed into the computer continuously after the engines are started.

Six modes of operation are scheduled—takeoff, climb, present cruise condition, maximum range, maximum endurance and approach. If needed, other modes, such as minimum cost profile, also could be included.

The part that ADVISOR will play in a typical flight plan is as follows:

• **Preflight.** Crew programs into the computer the gross weight of the aircraft and total fuel weight. Consulting a chart for a particular day and runway condition, the pilot comes up with an index number from the takeoff chart for runway temperature and gradient, altitude, and relative wind. The index number is set into the computer, the selector is placed in the takeoff position and the aircraft is taxied into position. Thrust indicators show the per cent of thrust being developed for each engine. For comparison, a command marker shows the per cent thrust that should be available for the particular day from engine performance parameters which have already been set into the computer. Once the throttles are advanced for takeoff, the pilot glances at the thrust gages to see whether actual thrust is equal to predicted thrust and, having made this instantaneous check on power, he commences takeoff run.

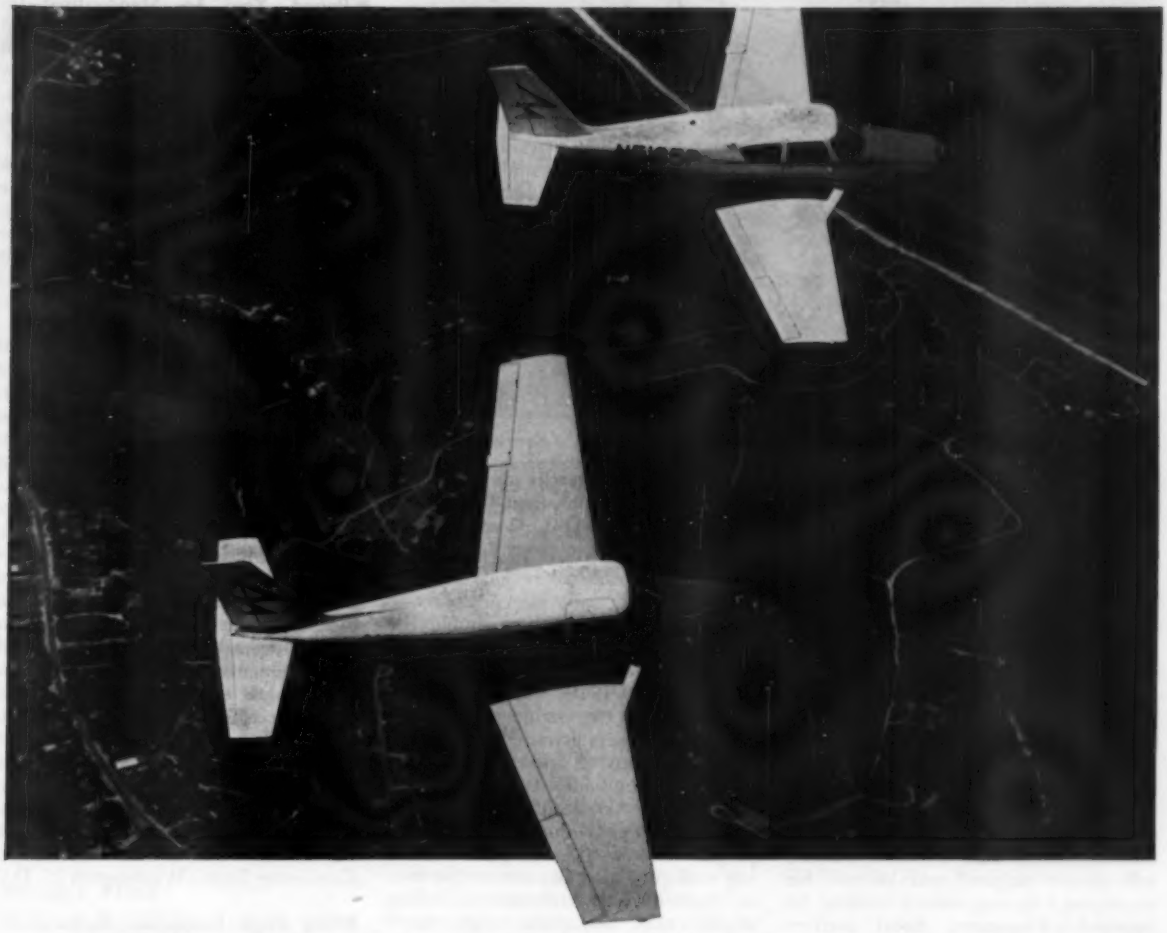
• **Takeoff.** Continuous "how-goes-it" information is provided by an index which moves around the periphery of the airspeed dial. Information is fed into this index by a cam and accelerometer which reports what aircraft takeoff performance should be. As long as the airspeed indicator is equal to or ahead of the "bug" (index marker), the takeoff is going according to schedule. Should too great a disparity occur, an amber light flashes, warning the pilot that takeoff is not going according to schedule. When V_1 speed (go, no-go speed) is attained, the index drops back to zero. Should the system malfunction, the index marker always will drop to zero rather than stay at any point on the dial. Similarly, all non-essential detail on the computer, such as range information during takeoff, climb or approach, will be blanked out when not needed or if malfunction occurs.

• **Climb.** Once 400 ft.-altitude is attained and the aircraft is cleaned up, the pilot switches to climb mode. The in-flight "bug" on the airspeed dial then moves into position to show the best climb indicated airspeed (IAS) for aircraft gross weight. Command thrust markers, which derive information from Exhaust Pressure Ratio (EPR) instruments, also show the per cent thrust to be used for climb. ADVISOR is built to drive the index marker so that a constant Mach number climb schedule is maintained.

• **Cruise.** Once the assigned altitude is reached, switch is placed in present position (PRES.) and ADVISOR shows how far the aircraft will go and time remaining on available fuel at the present altitude, IAS and per cent thrust. Distance and time remaining are presented on digital type indicators. Wind component determination can be made by the crew and set into the

KNOB marked "TO READY" on ADVISOR control panel is green light which resets computer and also serves as checkout of system. V_1 speed is set into computer before actual takeoff.

GENERAL MOTORS COOLS POPULAR PIPER COMANCHES!



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Engine heat gets the "Indian sign" from Harrison in these Piper Comanches! Piping hot in popularity, they cruise cool with lightweight, durable Harrison heat exchangers. Both Comanches shown, the four-cylinder 180 and the six-cylinder 250, are ideal for the modern business executive . . . for the man on the move! Naturally, Piper must demand absolute dependability. That's why Harrison is specified for engine oil cooling on these two featured stars of the Piper business fleet. Piper and manufacturers of every type of modern aircraft, from transcontinental bombers to city-hopping helicopters, rely on Harrison for the finest in cooling equipment. Harrison offers engineering excellence, production skill and never-ending research backed by nearly a half century of experience in the heat-control field. If *you* have a cooling problem, look to Harrison for the answer!

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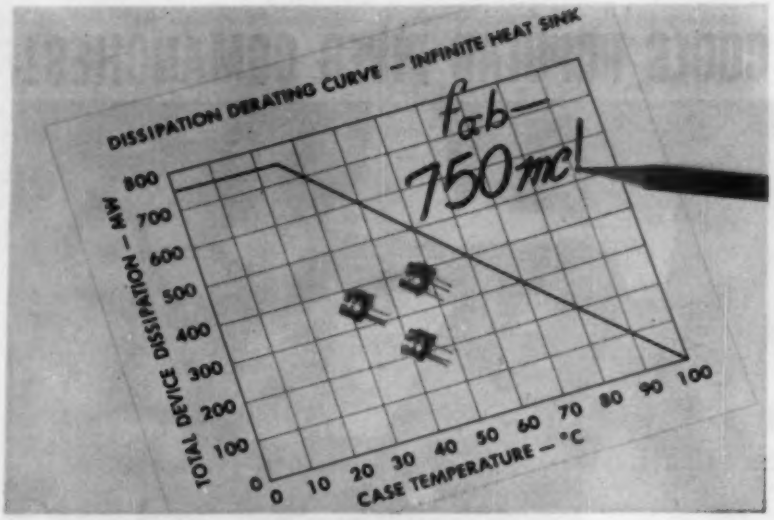


UHF Transistors

Ultra-high frequency germanium transistors, with alpha cutoff frequencies up to 750 mc. and power dissipations of 750 milliwatts, are now commercially available from Texas Instruments, Inc. New diffused-base P-N-P "mesa" transistors, Types 2N1141, 42 and 43, offer current gains of 12, 10 and 8 db. respectively at 100 mc. with 750 mw. power dissipation at 25C case temperature. Units are enclosed in welded JETEC TO-5 package.

computer or be supplied to the computer automatically through a Doppler radar tie-in. At any time during flight, the pilot can immediately determine the best altitude and airspeed for maximum range or maximum endurance by switching to the respective mode. Maximum range position will tell at any time what the best altitude and airspeed will be for maximum range. Similarly, maximum endurance mode tells proper airspeed and altitude for maximum loitering, should holding be required. Command thrust markers also show the best throttle setting for the particular condition selected. The pilot may, at any time during flight, set any altitude into the computer. Thus, he can determine range and time remaining at any altitude should it be necessary or advisable to climb or descend. Should it be necessary to go to an alternate once terminal is reached, the pilot can switch to maximum range mode and ADVISOR will immediately tell the best altitude and remaining range for the fuel aboard, thus avoiding trying to reach an alternate which is too remote.

• **Approach.** Mode is selected just prior to or during descent. The same index marker used for indicating the best climb indicated airspeed will then indicate the correct speed for final approach considering aircraft gross weight. Maximum lift ratio (C_L) also is cranked into the computer so that best approach indicated airspeed changes according to flap setting.

ADVISOR has four buttons on the lower left of the control panel. Should an engine failure occur, or should the pilot consider shutting one engine down, the corresponding button is pushed. ADVISOR then shows aircraft three- or two-engine performance and also considers asymmetric and trim drag conditions should failure be of the "two-on-one-side" type. The buttons on the ADVISOR panel do not affect the engines—they merely change programming of the computer according to flight-tested parameters for two- or three-engine performance during climb, cruise, maximum range, etc.

ADVISOR is only as good as the information it receives. One of the most difficult measurements to take in flight has always been free-air temperature, critically important because of its close relationship to Mach number. Convair's solution to this problem, according to Don Germeraad, chief test pilot for the 880, is the development of a stagnation type temperature probe with a very high recovery factor—a significant achievement in aircraft instrumentation.

Total weight for the ADVISOR system varies between 50 and 58 lb., depending on whether round or vertical-reading thrust gages are used. Total space requirement is 0.645 cu. ft., with vertical-reading thrust meters requiring an additional 0.128 cu. ft.

Power requirement for the complete system is 86 watts at 28 volts d.c. and 176 volt-amp. at 115 volts, 400 cps.

The ADVISOR system has been flight-tested in Boeing B-52s with satisfactory results, according to John Oster Co.

FILTER CENTER

▶**Pound, Yard Are Standardized**—International values of the pound (0.45359237 kilograms) and the yard (0.9144 meter) have been adopted by national laboratories of United States, United Kingdom, Australia, Canada, New Zealand and South Africa, effective July 1. The international yard, and international inch, are approximately two parts per million shorter than values formerly used by U. S.'s National Bureau of Standards, and slightly longer than the units previously used by United Kingdom.

▶**Nothing New Under the Sun**—New 121-page report entitled "A History of Aircraft Cockpit Instrumentation: 1903 to 1946" confirms the old adage about there being nothing new under the sun. For example, vertical indicating instruments, the "new look" in Air Force instruments, were being employed for some functions in aircraft as early as 1923. The report also discloses that in late 1920's Lt. James H. Doolittle, seeking to simplify cockpit instrumentation, recommended use of the cross-hair arrangement now in vogue in which all instruments that affect pitch attitude are arranged in a horizontal line while those affecting heading are grouped in a vertical line. Investigations of possible air collision warning devices were under study prior to 1930, the report reveals. The profusely illustrated report, identified PB 151186, can be obtained for $2.75 from Office of Technical Services, Commerce Dept., Washington 25, D.C.

▶**New High Resolution Radar**—Goodyear Aircraft Corp. advanced electronic center has developed new techniques which make it possible to produce extremely small radar beam with modest size aircraft antenna, giving extremely high resolution for aerial reconnaissance and mapping, company reports. New high resolution radar was developed under Wright Air Development Command sponsorship.

▶**Acoustic Emission Confirmed**—Recent study has confirmed that certain metals will emit acoustic noises when under applied stress and discloses possible relationship between emission and dislocation action. The study did not, however, verify earlier finding by a German scientist that for a given material there is a characteristic distribution of frequency and amplitude spectrums which is related to material's stress level and to its previous metallurgical history. Report on the study, identified PB 151215, is available from Office of Technical Services, Commerce Dept., Washington 25, D.C. at $1.25.

Lease Companies Push for Airline Deals

By William H. Gregory

New York—Airlines are being increasingly tempted with offers from leasing companies, some formed in the last few months, to obtain their new turbine equipment on long term leases rather than outright purchase.

Thus far airlines have generally rejected these offers, which may also include an option to buy. American Airlines' arrangement with Allison, General Electric and Pratt & Whitney for engines (AW Aug. 4, p. 38) might be considered an expectation; it may have even started the leasing ball rolling. But a deal directly with a manufacturer is an important distinction.

The great leasing debate boils down to these essentials:

• **Cost.** Airlines and some bankers say leasing is more costly to the airline—either in direct interest costs or in loss of revenue that might otherwise have been gained from ownership of the airplanes. Leasing companies argue that airlines fail to realize the "true cost of capital."

• **Ownership.** Airlines have a basic reluctance to lease on a large scale. The idea of not owning the piece of equipment they are built around, their primary revenue-producing unit, seems repugnant to them.

Leasing's Place

Leasing does have a place to fill in airline financing. How big and where that place is, is the question that generates the arguments.

Three phases are generally conceded to have a valuable future:

• **Ground handling equipment.** Even airlines strongly averse to leasing airplanes on a large scale view this possibility with great interest. An example might be an intermediate stop, served by two or three carriers but each with only one or two jet flights a day. Rather than each buy a starter cart, the three might jointly lease one.

• **Leasing among airlines,** that is on the order of the Swissair-SAS agreement to share a Convair 880 fleet (AW Oct. 13, p. 41) or the National-Pan American interchange (AW Sept. 15, p. 38), offers potential. The goal of these arrangements, to match off-seasonal peaks of one carrier with slumps of another, is highly sought by the airlines, but some practical difficulties interfere. Differing cockpit layouts which confuse pilots is an example.

• **Leasing** of small numbers of aircraft for short time periods for emergency use has always played a part in airline operation and will continue to do so.

Bankers tend to be skeptical of airline leasing. Their attitude is influenced to some extent by the money market, their opposition depending on how tight the money market is. Furthermore, a banker interested in local service airline financing might be much more favorable to leasing as a way to solve a feeder line's financing problems than a banker for a trunk line with a top credit rating.

This last point is a big stumbling block, however. Leasing companies often enough are no more receptive to a financially pressed airline than a lender; both want assurance of the airline's ability to make payments.

Some leasing companies distinguish between shell companies acting merely as middlemen, in effect borrowing from a bank on the airline's credit and pocketing the added interest themselves, and those who can supply their own resources.

Bank Loans

Banks will lend up to 75% of the cost of an airplane. One company is considering putting up the other 25% itself although it would prefer to have the manufacturer share in this.

Bankers see possibilities in this method, but do not feel now is the time since most airlines have been able to arrange at least minimum borrowing for their new equipment and should be able to handle the rest if cash flow meets expectations from operating revenues.

As one banker put it, the day may well come when the manufacturer will roll out the last five airplanes of a carrier's jet order and will find the carrier can't make the final payments. The manufacturer then will have alternatives as:

• **Sue the airline** for payment.

• **Hold the airplanes** in inventory.

• **Finance the sale itself** either by taking a subordinated note or handling the deal as a lease through a leasing company.

The first is unpalatable as a customer relations matter, let alone the delay and cost involved in extracting payment, and the second may be out of the question because of the manufacturer's own problems with debt (AW July 7, p. 54). Thus, this banker feels the manufacturer ought to have its own credit resources for the third alternative and not use them now.

CAB Policy

Another obstacle to leasing can be Civil Aeronautics Board policy. For the nonsubsidized carriers, how the CAB will determine rate of return is an important consideration. If this is determined on an investment base, payments on a lease might not be included.

Subsidy for the local service carriers is figured on an investment base and has forestalled leasing to these airlines. United States Leasing Corp. of San Francisco is working on a plan for these carriers, however, which would involve CAB considering lease payments as depreciation for subsidy purposes.

Several other leasing companies are taking an interest in the airline field. Intermediate Credit Corp. (AW Aug. 25, p. 32) is one. Andre and John de Saint-Phalle of New York is another, a company recently established to deal in aviation financing generally and with interests in lease plans for airlines.

There are many variations in opera-

START and electric power truck is part of ground equipment used on Eastern Air Lines Lockheed Electra turboprop transport at New York (AW Jan. 19, p. 38).

CECO NEWS

CHANDLER-EVANS SYSTEMS • CONTROLS WEST HARTFORD, CONNECTICUT

New Center Has Unique Features

The Control Console in CECO's newest test facility incorporates latest state-of-the-art instrumentation and provides for push-button ease of operation. Any malfunction in any part of the system activates both audible and visual alarms. Electrical interlocks automatically shut down the system and indicate the specific area of malfunction.

If the operator does not or cannot take the necessary corrective steps within a predetermined amount of time, required corrections are made automatically and the test is resumed.

Engineered for Safety

While the Test Platform with its Ambient Chambers can easily be seen through a maximum safety window in the forward wall of the Control House, all tests are 100% remotely controlled. Operators set and control temperatures and pressures, and assemble all necessary data at the Control and Instrumentation Console.

The entire CECO Thermo-Research Center has been painstakingly engineered to provide optimum safety, both for operating personnel and for the valuable mechanisms being tested.

So thorough are the safety precautions that despite the hazards inherent in handling fuels at elevated temperature, lowest premium cost fire insurance premiums on this facility are in the category ("Sprinkler Rating").

Described as "Operator-Proof"

A highly complex operator-overriding system, developed especially for this facility, assures proper operation at all times. Operator errors, if and when they occur, are corrected automatically.

Fuel Density Indicator

A meter in the Control House gives continuous indication of fuel density. It gets its signal from the intensity of radiation through a section of the fuel conduit. Isotope Cesium 137 is used in this radiation process.

Chandler-Evans Announces New High-Temperature Test Center

LATEST CECO DEVELOPMENT TOOL: Two structures make up the Chandler-Evans Thermo-Research Center. One (shown above in foreground) is a concrete and steel, insulated and soundproofed Control House.

The second structure (background above) is an "open air" Test Platform, sheltered from the elements by a sheet metal roof containing plastic blow-out sections. Test Chambers and all associated equipment are installed on this platform.

CECO Facility Tests Fuel Devices In Environments To 1000°F.

West Hartford, Conn. (CECO)—Completion of a new and vastly capable Thermo-Research Center has been announced by Sidney A. Stewart, General Manager of Chandler-Evans. The 100% company-owned facility is considered to be unique in the modern aircraft industry. It is designed to subject sensitive fuel mechanisms and other hydraulic devices to elevated temperatures similar to those developed in ultra high-speed flight.

As a development tool, the Center is expected to provide answers to many questions that have perplexed engineers since advanced air speeds first began to create critical high-temperature problems.

Chandler-Evans has been "hot-testing" aircraft engine accessory products for a number of years. Initially, relatively simple facilities were equal to the task. But, as aircraft and missile speeds advanced into Mach ranges, it became apparent that tempera-

(to accommodate 300-hour fuel system tests, for example) can be carried out twenty-four hours a day, seven days a week.

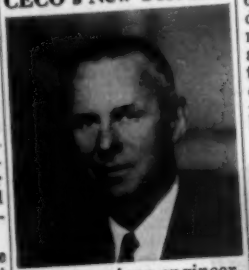
Others to Use Lab

CECO's new Thermo-Research Center has been made available to others, according to Ercole J. Vitali, Manager of the Company's Engineering Test and Experimental Departments.

On a limited basis, the laboratory and its staff will be put at the disposal of manufacturers who are similarly concerned with the functional performance of liquid fuels, fuel system components, and other hydraulic equipment when subjected to the stresses of elevated temperature. Ambient and fuel temperature capabilities currently specified are 1000°F. and 500°F. respectively.

Vitali went on to say that subcontract customers can gain valuable time and save money as well by calling on CECO's

S. A. Stewart Lauds CECO's New Test Lab



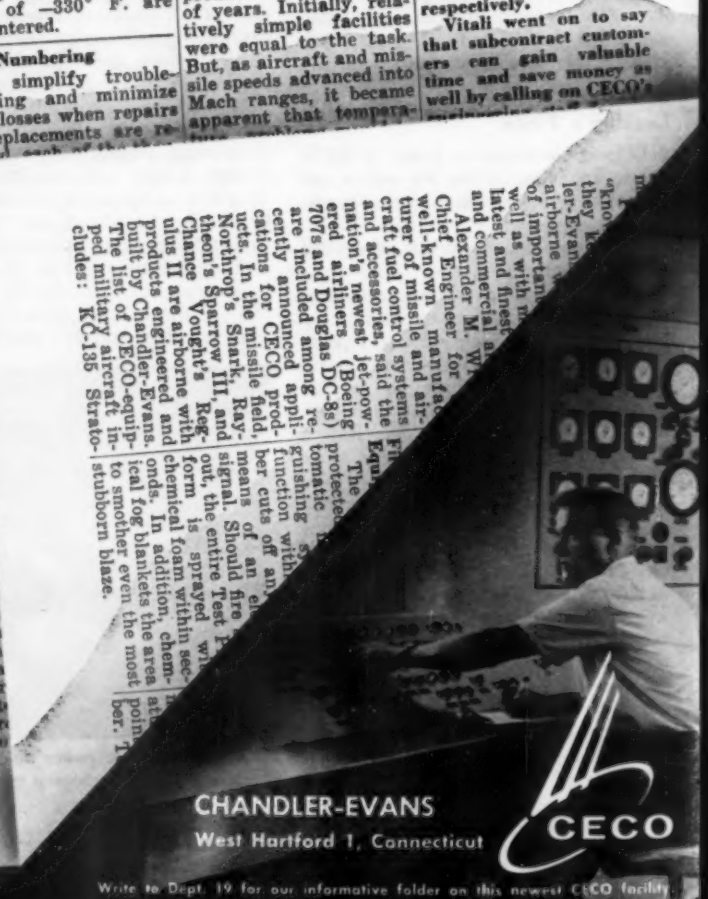
"This unique engineering tool will enable CECO to continue developing superior products empirically," said Sidney A. Stewart, General Manager of Chandler-Evans, when the company's new Thermo-Research Center was unveiled for the aircraft industry.

He went on to point out that high-temperature problems have become increasingly critical with advancing speeds of air and space vehicles. "We expect to find in this new laboratory definitive answers to a variety of questions relative to the precise metering of liquid fuels at high temperatures," he said.

Further underscoring the importance of *temperature extremes* in the modern aircraft and missile industry, Stewart mentioned concurrent activities in the cryogenics field. He said CECO is designing and producing devices for use in liquid nitrogen systems, for example, where temperatures of —330° F. are encountered.

Part Numbering

To simplify trouble-shooting and minimize time losses when repairs or replacements are re-



CHANDLER-EVANS
West Hartford 1, Connecticut
CECO
Write to Dept. 19 for our informative folder on this newest CECO facility.

tion of leasing companies, but it usually goes along these lines.

Through credit sources they have established, they borrow the money to purchase the airplanes. On leasing them to the airline, the company would then charge a percentage above the rate it had to pay—usually 1-3%. Thus if the leasing company had to pay a hypothetical prime rate of 4%, it might in turn charge the airline anywhere from 5-8%, or perhaps more.

If the choices were simply borrowing on one hand versus leasing on the other, leasing probably would be the more expensive. But using a recent airline financing arrangement as an example—Eastern Air Lines—the pros and cons can become more difficult to untangle.

To complete its Lockheed Electra and Douglas DC-8 financing, Eastern set up a $50 million revolving line of credit with a group of banks. Interest rates are to be prime at the time of borrowing through 1961 with minimum-maximum limits of 3½-4½%, and ¼ of 1% over prime after that with limits of 3¾-4¾%. (These terms were reported incorrectly previously by Aviation Week as 1% above prime—(AW Dec. 15, p. 37).

If these were the only terms, then leasing proposals at ¼% above prime obviously would be less favorable.

However, Eastern also borrowed another $25 million at 5% through a convertible promissory note purchased by the Prudential Insurance Co. Thus, had Eastern also been considering leasing, it would have faced a thornier choice between potentially higher costs in leasing versus potential dilution of its common stock through conversion of the note.

This is the nub of the leasing companies' arguments on "the true cost of capital." They point out that to the stockholder, any dilution of equity is a permanent cost of capital and may far exceed any difference in direct interest costs. Use of retained earnings also is computed as a cost of capital by them; that is, the stockholder is denied distribution of retained earnings as dividends and, in their view, is entitled to a return on these funds equal to what they would have provided him if they had been added to earnings.

Bankers and airline people, however, feel that some broadening of airline equities might be desirable. One ratio used by banks in lending for equipment is the size of the airline's equity base in relation to the size of the loan, and this marks one way of setting a depth ceiling.

Leasing does not offer much opportunity to solve the problem of debt ceilings. Banks now regard the total cost of a lease as debt and add it to the total loans of the airline in computing ratios.

Eastern's note to Prudential has several clauses that might eliminate conversion. Some airline executives feel that, at the current high level of the market (AW Jan. 19, p. 47), selling additional common stock might be advantageous in any event.

Japanese Build Sikorsky S-55s

One of two Mitsubishi-Sikorsky S-55 helicopters built in Japan under license gets final check at Komaki plant of Mitsubishi Heavy Industries. Work started last October.

One is William J. Hogan, executive vice president-finance of American Airlines, who believes that it might be to American's advantage to obtain some additional equity financing because of the high price levels even though American's equipment program has been financed. Todd G. Cole, vice president-administration finance for Delta Air Lines, is another who has mentioned this possibility.

Future Uncertainties

Hogan pointed out that because of future uncertainties—what used piston equipment will bring, among them—the elements of future cash flow are uncertain. And American is counting on about $200 million from this source to pay its jet equipment balance not covered by loans. "In view of such uncertainties," he said, "prudence indicates the desirability of a strong cash position and an adequate equity base."

American embarked on its celebrated leasing program on the basis of this reasoning, and Hogan has pointed out that it has reduced American's immediate requirement for capital by $80 million.

The value of this "saving" is perhaps the most debated point in leasing, the pros and cons lining up something like this:

- **Need for borrowing** the $80 million now is avoided.
- **Progress payments** are not required as in the case of purchase.
- **With an option to buy,** American can acquire the equipment if market and business conditions make such a course desirable.

On the other hand, American does have to pay the $80 million eventually, amortizing the cost of the engines over the time of the lease.

Leasing companies quote additional advantages along these lines. Leasing prevents depletion of working capital, they say, and adds flexibility. For example, it might give an airline time to obtain market financing at more favorable terms as earnings increase through use of the new, leased equipment.

There are several other possible drawbacks to leasing with leasing companies which American may have escaped by dealing directly with the manufacturer. What American's lease amounts to is that Allison or General Electric must use their credit resources to carry the equipment rather than having American use its credit. Besides the possible extra cost, these other drawbacks are:

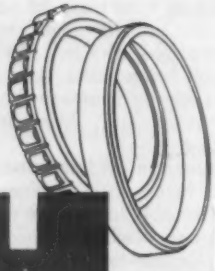
- **Tax deductibility** of leasing payments is a highly complicated matter and difficulties may result. Interest on debt is also deductible and with purchase the possible residual value of the equipment may be quite profitable.
- **Depreciation throw off** on purchased equipment has added tax advantages.
- **Revenue earning** capacity of the equipment lies with the purchaser. Thus in a long term lease, 10 years, for example, the aircraft might be completely amortized after five. Whatever the airplane brings after that is pure profit to a leasing company that owns it. Airline people feel: "Why shouldn't we have that gravy?"

(The American Airlines situation is analogous here since engines alone would not be able to produce revenue.)

There are no black and white answers in leasing. Circumstances usually dictate any decision; advantages in the case of one airline may become disadvantages for another. In the end result, necessity may be the final arbiter.

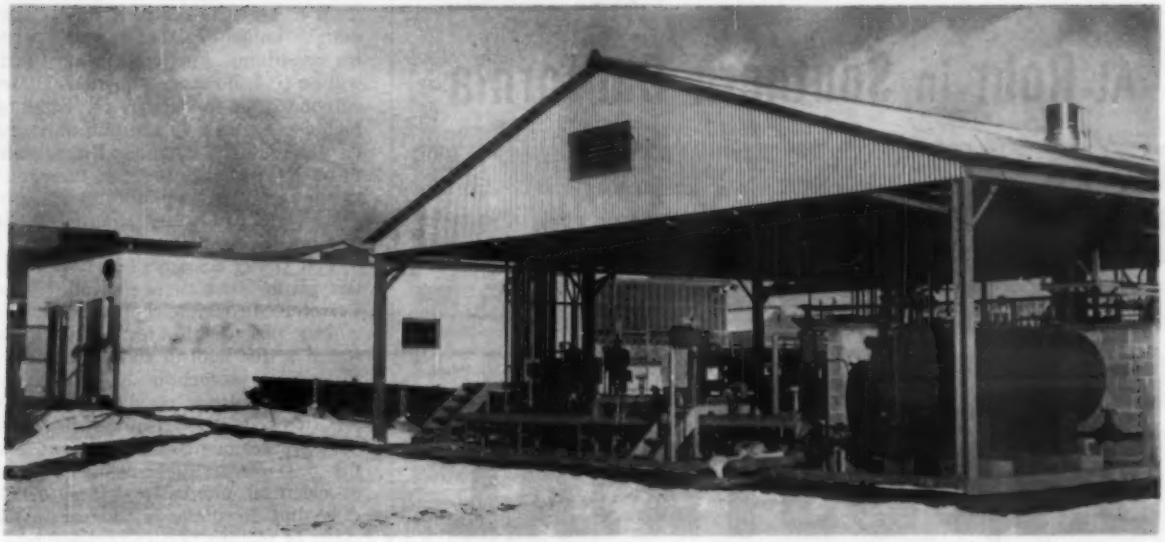
HYATT HY-ROLL BEARINGS IN P&W JT3 ENGINES HELP THE BOEING 707 SHRINK THE WORLD

HYATT HY-ROLL BEARINGS in each of the 4 Pratt & Whitney JT3 jet engines help the Boeing 707 cruise smoothly at 600 mph. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.



Another GM GENERAL MOTORS contribution to aviation progress

HYATT HY-ROLL BEARINGS FOR AIRCRAFT INDUSTRY



FUEL TEST platform is controlled from reinforced concrete control house, rear. Jet fuel is supplied from 1,000 gal. tank, lower right, protected by concrete wall. Lines leading to control house remote permit control and supply fire extinguishing foam and water.

Facility Tests Fuel Controls at 500F

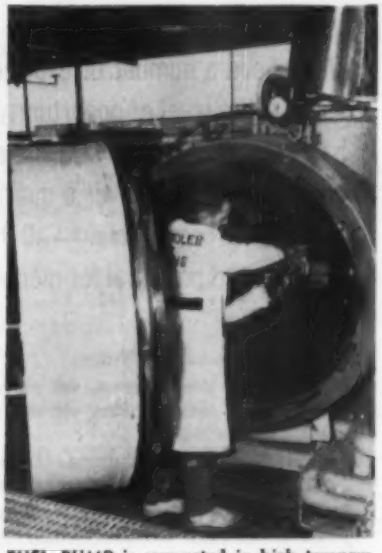
By Barry Tully

West Hartford, Conn.—Fuel temperatures to 500F, pressures to 1,500 psi. and flow rates to 100,000 lb. per hr. are used to test fuel system components at Chandler-Evans Corp.'s new test center.

The test center, designed to submit fuel controls to temperatures and pressures anticipated in next generation high speed aircraft, operates components under 1,000F ambient temperatures. Temperature ranges of the platform are determined by the requirements of upcoming fuel system components. Chandler-Evans facility and others in the industry, including one at Hamilton Standard Division of United Aircraft, are designed for future upgrading to provide testing of fuel at temperatures approaching 1,000F.

Initial operation of the Thermo-Research center at the company plant here coincides with a change in corporate structure. Chandler-Evans, formerly a division of Pratt & Whitney Co., Inc., machine tool builders, now exists as a separate corporation but the two corporations will continue to operate under the same roof at West Hartford. Sidney A. Stewart, formerly general manager of the Chandler-Evans Divi-

TEST ENGINEER seated at control console observes test platform through maximum protection window. Telephone connects controller with technicians on test stand.



FUEL PUMP is connected in high temperature test chamber. Note explosion-proof door.

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We believe a number of experienced Industrial Engineers are seeking the level of opportunity that rapid company expansion has created at Rohr. Current employment of over 18,000 — current backlog of over a quarter billion — current contracts over 60% commercial — all help to illustrate the unusual security and potential for men with a flair for accomplishment.

Assignments: Manufacturing Methods

Responsibilities: Include machine and man-power utilization, plant layout, facilities, sequence planning and bar charting, etc.

Requirements: Age 25-40 preferred, I.E. Degree desirable, minimum 3 years aircraft experience.

So that a personal interview may be arranged soon, please forward a detailed resume at once. Address J. L. Hobel, Industrial Relations Manager, Rohr Aircraft Corporation, Chula Vista, California.

ROHR
AIRCRAFT CORPORATION

Chula Vista and Riverside, California

sion, is president of the Chandler-Evans Corp.

Prime function of the research facility is to test new company fuel control designs under expected future operating conditions. Fuel used in most tests will be JP-5; however, provisions are incorporated in the design for handling high energy fuels. In addition to testing its own designs, Chandler-Evans plans to offer the facility to other companies in the industry on a subcontract basis. Several companies are reported to be interested in using the new facility.

Test center consists of an "open air" test platform which is controlled from a reinforced concrete control house. Engineers observe the test stand while seated at the control console behind a maximum protection glass window. Safety precautions are dictated by the fact that temperatures often exceed the auto-ignition point of the fuels used in the test. Precautions include a series of electrical interlocks that automatically shut down the installation in the event of malfunction or overheating.

The test platform, measuring 46x40 ft., is protected from the weather by a sheet metal roof containing corrugated plastic blowout sections. Fuel loop consists of a boost circuit and a high temperature/pressure or "hot" circuit connected in parallel. Boost circuit, containing a 1,000 gal. fuel tank, provides boost pressure and makeup fuel to the hot loop. Control valve in this low pressure circuit maintains a preset pressure unless overridden by boil-off control which reduces boiling in the hot loop. Fuel in the boost circuit is maintained at temperatures between 80 and 120F and a pressure of 82 psi.

The high temperature circuit of the fuel loop contains two high temperature test chambers to test fuel pumps and fuel system controls. Heat is supplied to the fuel and controlled by 137,000 Btu./hr. electrical heaters, 550,000 Btu./hr. steam heaters and 510,000 Btu./hr. water coolers.

Fuel pumps, located in the pump test chamber upstream of the fuel control chamber, are powered by a 200 hp. General Electric 750-7,000 rpm. Varidrive motor. Pump can create a fuel flow in the control test chamber of 71,000 lb./hr. at 1,500 psi. pressure. After passing through the control test chamber, fuel rejoins the system at the temperature control units.

The two test chambers in the system, constructed by Tenney Engineering Co., Union, N. J., maintain an ambient temperature to 1,000F in an atmosphere of carbon dioxide around the component under test. "Sniffers" within the chambers provide a constant check of the fuel/air ratio within the chamber. Chambers are designed to withstand the maximum achievable pressure transients caused by an internal

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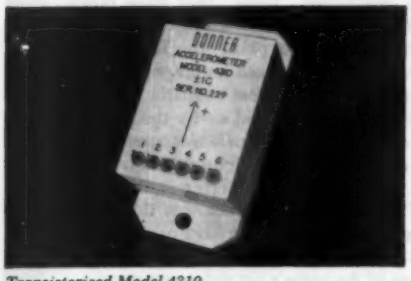
Using only a few ounces of force, anybody can walk a helicopter fitted with automatic stabilization equipment using a Donner designed stabilizing coupler. In a more useful vein, the big birds perform vital tasks where the ability to hover precisely and maintain stability is critical. Currently, Donner equipped Sikorskys are used extensively for submarine detection, surveilance, rescue, lifting, and a host of other activities.



Transistorized Model 4310
0.1% linear accelerometer shown 1/2 size.

Heart of the Donner coupler is a small Donner servo accelerometer which measures linear acceleration to at least 0.1% of full scale. The internal servo system offers excellent resolution and linearity. These sturdy reliable instruments are hermetically sealed and magnetically shielded. The entire Donner system weighs less than 25 pounds.

Complete information is contained in Data File 410. Send for your copy without obligation — use the convenient coupon.

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Ryan Firebee

jet drone missiles

are flying longer, farther, higher, faster on target missions—and more of them "live" to fly another day.

For example, at Vincent Air Force Base recently, the 4750th Drone Squadron launched 44 Firebees *in a row*, which averaged one hour's flight duration each. And 39 of them—many after target "hits"—were recovered successfully for re-use!

Other Firebee firsts: the one that completed 19 missions; the one that flew 1 hour, 42½ minutes; the one that made a flight 152 miles away from ground control and returned to be recovered in a pre-selected area; the drones that regularly fly target missions at Mach .9; and the *production* "birds" that have flown above 50,000 feet.

An elusive, pilotless plane, the Ryan Firebee is the most widely used jet target in training operations... the most realistic stand-in for "enemy" aircraft. That's why the Firebee is used as the target for such weapons as the Air Force Falcon and Genie; Navy Sidewinder, Sparrow, and Terrier; and Army Nike. That's why the Firebee was the exclusive target drone used in the Air Force's recent Project William Tell to evaluate the combat readiness of America's air defense system.

RYAN BUILDS BETTER

AIRCRAFT · POWER PLANTS · ELECTRONICS

Ryan Aeronautical Company, San Diego, Calif.

explosion. Cooling system within the test chamber can lower the ambient temperature from 1,000F to 80F in one hour.

Preliminary tests with the new facility have been made only with pumps and results, therefore, are inconclusive. However, engineers report that existing hardware has proven capable of withstanding the higher temperatures if improved seals can be developed.

PRODUCTION BRIEFING

Kreisler Industrial Corp., Paterson, N. J., has developed methods of bending titanium tubing to angles up to 90 deg. with radii equal to the outside diameter in some configurations. Production use of the technique would

save both weight and space in missile applications. Cold bending method, developed with Superior Tube Co. A-40 grade titanium tubing, requires drawing the tube around a rotating bending form.

Aircraft Service Shops Section of General Electric Co. will supply overhaul and repair service for operators of Rotol turbo propellers. Servicing agreement was signed with Rotol Inc., Arlington, Va., subsidiary of Rotol Ltd., England. Repair facilities are now available at North Bergen, N. J., Seattle, Wash., and Ontario, Calif. Facilities are planned for Cincinnati, Ohio, and Arkansas, Kan.

Clary Dynamics, San Gabriel, Calif., will produce gyroscopes, servo-actuators and valves for the Corporal missile under $700,000 Firestone Tire and Rubber Co. contract. Delivery of the components for the Army missile will be made during 1959.

Tenney Engineering Co., Union, N. J., will build a $250,000 environmental chamber for vibration testing at Sperry Gyroscope Co. Chamber, measuring 12 x 14 x 18 ft., will house a vibration machine generating 21,500 lb. of force up to 2,000 cps. Environmental chamber will have a temperature range of −100 to 350F, pressure altitude of 120,000 ft. and ram air simulation.

Colonial Aircraft Corp., Sanford, Me., is building its MC-5 Martar targets (missile airborne radar target) for the Air Force. The 8 ft., 20 lb. aerial tow target is fabricated from foam plastic and glass fiber laminate. Its production marks the lightplane manufacturer's first Air Force prime contract.

United Control Corp., Seattle, Wash., will supply temperature control systems to cool Tacan gear on 1,100 F-86F fighters. System consists of a multi-channel transistorized controller and two cooling effect simulators. Retrofit program is under contract from North American.

Beryllium Corp., Reading, Pa., will carry out research and development of beryllium metal extrusion into aircraft structural shapes under contract from Northrop Aircraft, Inc. Northrop is the holder of a prime contract for beryllium research from the Manufacturing Methods Division of the Air Materiel Command, Aeronautical Systems Center, Wright-Patterson AFB, Dayton, Ohio.

Consolidated Electrodynamics Corp., Pasadena, Calif., will build monitoring equipment for airborne fire control systems under $458,000 contract from General Electric's Light Military and Electronics Dept. Dynamic measuring and recording equipment will include Consolidated Electrodynamic's recording oscillographs and galvanometers.

Aeronca Manufacturing Corp., Middletown, Ohio, will produce brazed stainless steel panel assemblies for the Convair B-58 under $700,000 contract. Order, calling for approximately 650 wing pylon panels and 260 elevon rib panels, will extend into the second quarter of 1960.

B.T.R. Industries Ltd., British conveyor belt manufacturer, is planning to buy Microcell Ltd., aircraft engineering, plastics and electronics firm. Price is estimated at $1.5 million. B.T.R.'s profits for the year ending Sept. 30 were just over $2 million compared with $3.6 million the previous year.

Yardney Electric Corp., New York, N. Y., will furnish its silver-zinc batteries for the Bomarc missile under $932,870 contract from Boeing. Batteries, called Silvercels, provide the basic energy source for the hydraulic controls, guidance and telemetry.

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Aline your missile-launchers and your mobile radars fast—with celestial accuracy—any weather, any time of day. Do it with ABLE, Autonetics' Base Line Equipment. ABLE is a portable field instrument designed to find True North or any other base line—automatically. ABLE is reliable, easy to operate and maintain.
Please write for literature. **Autonetics**
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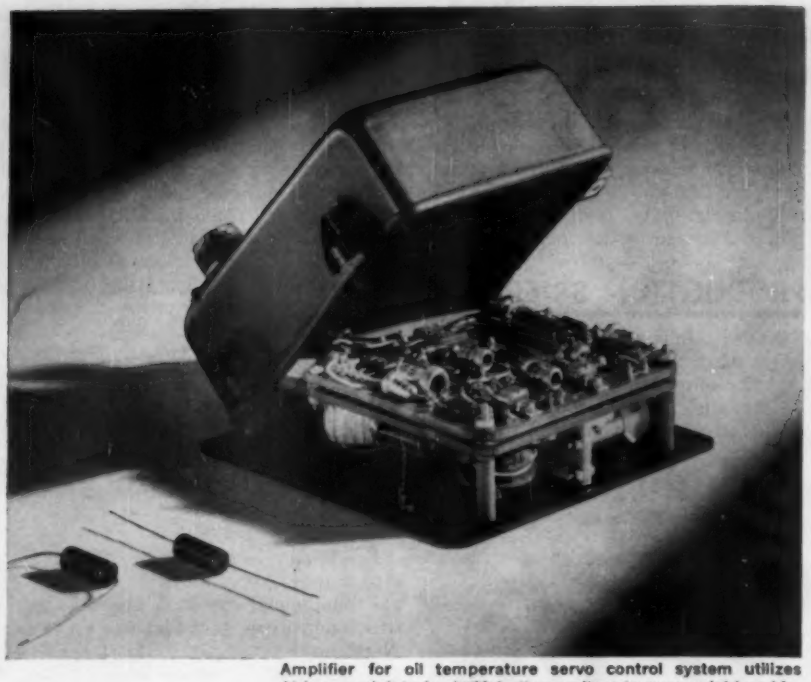
Airborne Miniaturized Mylar* Capacitors help **reduce weight and bulk** in electronic packages



Amplifier for oil temperature servo control system utilizes Airborne miniaturized "Mylar" capacitors to save weight and insure high reliability. Entire system, including rotary actuator, is Airborne produced and is designed to meet specifications MIL-E-5272A, MIL-E-5400A, etc. Environmental requirements include −65 to +200°F. and up to 60,000 ft. altitude.

Developed originally for motor start and run purposes, Airborne miniaturized "Mylar" capacitors are currently finding increasing application in electronic circuits where small size, light weight, and high reliability are of paramount importance.

Typical of such applications is one of our *own* servo control amplifiers, shown above. Used as a component of an Airborne-designed oil temperature control system for high performance aircraft, the amplifier consists of a .1% precision resistance bridge, stable feedback transistor amplifier, reference oscillator, phase demodulator, and relay output amplifier. Production units employ printed circuitry.

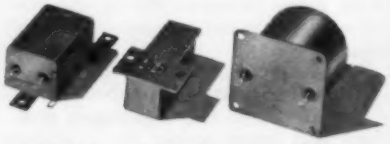
Two of Airborne's miniaturized "Mylar" capacitors are utilized in this particular amplifier — a .1 mfd unit for tuning in the reference oscillator section of the amplifier and a .02 mfd unit for phase shift correction in the stable feedback transistor amplifier section. Capacitors are epoxy encased and are designed to meet or exceed Government specification MIL-C-25A.

Wound of thin metallized "Mylar" film, Airborne miniaturized capacitors are rated up to 600 v d-c, 330 v a-c and have an operating temperature range of −75 to +300°F. At 300°F they will withstand 120% rated voltage for 250 hr.

Write, phone or wire for more information on Airborne special design miniaturized "Mylar" capacitors. Inquiries are also invited on complete electromechanical control systems.

*Du Pont's trademark for its polyester film

TYPICAL SPECIAL CAPACITORS



E-8109 Style E-8104 Style E-8107 Style

CATALOG 57B

Gives detailed information on Airborne special design miniaturized "Mylar" capacitors and Airborne R.F. filters. Write for copy.

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NEW AVIATION PRODUCTS

Liquid Oxygen Lubricant

Anti-seize compound for use with liquid oxygen in missile applications safely reduces possibility of metal parts sticking.

Compound, designated X-1333, contains an anti-oxidant rather than a hydrocarbon base, thus eliminating danger of explosion due to oxidizing of hydrocarbon lubricants.

Lubricant was developed in connection with the Vanguard project.

Lehigh Chemical Co., Chestertown, Md.

Flow Control Valve

Pressure and temperature ¼ in. flow control valve tends to minimize flow variation in missile-handling hydraulic systems. Mechanism reduces average flow variations due to temperature changes by 75%, the manufacturer states.

Valve incorporates a hydrostat to compensate for load changes and a sin-

gle, adjustable throttle which permits finer flow rate adjustment throughout the specified range of any of six throttles previously required. Check valve provides for reverse flow; maximum reverse flow is 1,400 cu. in. per min.

Vickers Inc., Marine and Ordnance Dept., Waterbury 20, Conn.

Missile Servicing Nozzle

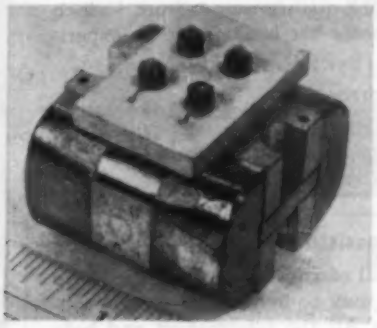
Nozzle and adapter for servicing missiles with propellants and other fluids. Seat construction of the nozzle permits 10 deg. angular and ½ in. longitudinal misalignment during transfer without breaking seal.

707 Suppressor Achieves 20-30 db. Attenuation

Jet engine noise suppressor, designed for direct attachment to engine tailpipe, is shown during evaluation on Pratt & Whitney JT3 engine of Boeing 707. Attenuation of the 650 lb. suppressor is in the 20 to 30 db. range. Intended for use by the airlines in silencing ground runup noise, the unit is designed to match the configuration of engines' in-flight suppressors. "CDA" Multi-jet (commercial, direct and attaching) suppressor is produced by International Aerocoustic, Inc., New York, N. Y.

Poppet type valve is operated by a plunger in the nozzle. Bellows system provides a pressure balance to ensure retention of seal during relative motion between erector and missile. Ambient temperature range is −320 to +160F; unit can be produced in various sizes.

Flight Refueling, Inc., Friendship International Airport, Baltimore, Md.



Missile Torque Motor

Torque motor is designed to operate in 600F ambient temperatures. Electromechanical transducer will permit the use of electrohydraulic or electropneumatic servo valves in missiles and high performance aircraft without cooling or thermal lag provisions, the maker states.

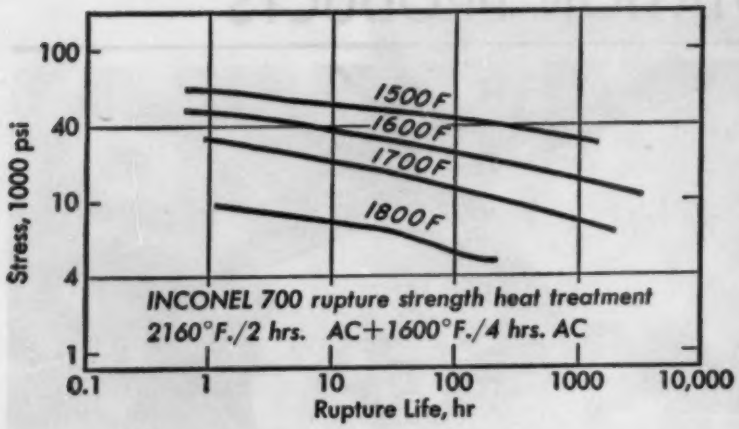
Model 103-2 has a midposition force of over 8 lb.; stroke of + or −.008 in. at a radius of .750 in.; measures 1⅛ x 1⅛ x 1¾ in. and weighs 10 oz.; and requires 4 watts of input electrical power.

American Measurement & Control, Inc., 240 Calvary St., Waltham 54, Mass.

Standardized Control Column

Control column, based on pilot rather than aircraft characteristics, is designed to provide "off the shelf" availability of control columns for new aircraft.

The prototype model of the column



New alloy! New strength!

Graph shows excellent stress-rupture strength of Inconel "700" in 1500° to 1800°F range

Inconel "700"* age-hardenable nickel-cobalt-chromium alloy is a new heat-resistant material developed by Inco to meet stress and temperature conditions beyond the range of Inconel "X"* age-hardenable nickel-chromium alloy. (Specifically, it goes beyond the operating temperature range of Inconel "X" by 100°F for the same rupture strength.)

Inconel "700" also has good corrosion and oxidation resistance. It can be forged, machined and welded.

Availability

Inconel "700" is available in forging quality rounds from ½-inch to 2-inch diameters. Larger diameter bar is available on experimental basis.

More information

For particulars on properties, send for the Inconel "700" basic data sheet. It gives graphs on yield strength, tensile strength, elongation; covers such data as composition, thermal conductivity and the like.

Technical assistance

Inco has accumulated a great deal of knowledge and experience in heat-resistant materials which may be helpful in solving problems involving missile hardware. All the information and help we can give you are yours for the asking. Just write.

*Registered trademark

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street — New York 5, N. Y.

The Nike Missile

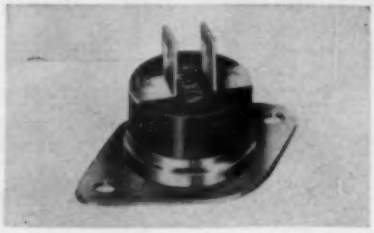
INCO NICKEL ALLOYS

NICKEL ALLOYS PERFORM BETTER LONGER

is now flying on the prototype North American Sabreliner.

Composite control column is designed to fit any aircraft heavy enough to warrant the use of a column by varying the booster system connecting the cockpit controls to the control surfaces. Column, with unconventional four-bar linkage and sector system, is connected with four bolts to the floor and five to control push rods. Unit fits all CAA and Handbook of Instructions for Aircraft Designers requirements.

Vard Inc., 2981 E. Colorado St., Pasadena 8, Calif.



Missile Thermostat

Thermostat for missile and shell fuse applications is designed to withstand impact loads to 20,000Gs.

Klixon M201 thermostat's switch action is single-pole, single-throw with double contact make and break. Stainless steel cup provides protection from dust and dirt. Life cycle is from 6,000 at 12 amp. to 100,000 at 2 amp., 120 v. a.c. Ambient temperature range is from −85 to +500F.

Metals & Controls Corp., Attleboro, Mass.

Low Temperature Chamber

Low temperature unit is designed for precipitation hardening of stainless steels used in aircraft and missiles. Chamber can bring 350 lb. of AM-350 stainless steel per hour from +80F to −120F, the maker states.

Model 4SR-120-64 has a 64 cu. ft. chamber measuring 48 in. x 48 in. x 48 in. Mechanical air convection facilitates the cooling operation in the chamber, which has a net thermal capacity of approximately 8,500 Btu. per hr. at −120F. Outside dimensions are: height 60 in., length 96 in., width 72 in.

Cincinnati Sub-Zero Products, 3932 Reading Rd., Cincinnati 29, Ohio.

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Brings out BEST in TIG Welding

This new Miller development improves quality, speed and range of tungsten inert gas welding in all automatic fixture and manual applications. Balanced wave (BW) characteristic results from new Miller balance control which eliminates the d-c component present in most welding currents. Output of the Miller BW welder is ONLY pure a-c, DELIVERS:

Excellent arc stability
Maximum heat
Deeper penetration
Faster welding speeds

Complete particulars will be sent promptly upon request.

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Projects include constant speed drives, hydraulic motors, pumps and other components for commercial and military aircraft and missiles.

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SUNDSTRAND Personnel, Dept. A, 1401-23rd Ave., Rockford, Ill.

SUNDSTRAND AVIATION

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26th ANNUAL INVENTORY OF AIRPOWER ISSUE

PUBLISHING DATE: MARCH 9, 1959

In twelve swift-paced months, aviation's galloping technology has made dramatic breakthroughs in all areas of flight. Commercial jet transportation became a reality. Corporate fleets can now pick from a number of turbo jet or prop jet aircraft. An ICBM has flown successfully over its full range of capability. Aircraft flying at twice the speed of sound are now operational with the USAF. Larger and more complicated satellites were hurled around the globe. Actual attempts were made to orbit the moon. Space Technology has excited the imagination of the entire industry.

Event followed event with such rapidity that interpreting their significance has been difficult for even the most well informed engineering-management men. Once again, they need a concise, penetrating analysis and forecast of world airpower.

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For the complete data on Edo Model 345 Airborne Loran, send for Technical Manual #501, Dept. 1-C.

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CAB Accident Investigation Report:

Premature Gear Raising Leads to Crash

An American Airlines Convair 240, N94213, aborted a takeoff at the New Haven Municipal Airport on March 1, 1958, about 1024.[1] The aircraft, with the landing gear retracted and the left nacelle and wing burning, skidded to a stop on the runway. Considerable damage resulted and two of the five passengers received minor injuries; the three crew members were uninjured.

HISTORY OF THE FLIGHT

This was scheduled passenger Flight 535 of March 1 from Boston, Mass., to New York, N. Y., with stops planned at New Haven and Bridgeport, Conn. The crew, consisting of Capt. Edward W. Johnson, First Officer Norman A. Paquette and Stewardess Marian Sullivan, reported to company operations at Boston well ahead of scheduled departure time.

Departure from Boston at 0927 was on time and was in accordance with an IFR clearance to cruise at 6,000 ft. via airways to New Haven. The flight was routine and on schedule to New Haven.

The aircraft was not refueled during the five-minute stop at New Haven, during which time both engines were stopped. The flight departed the terminal with five passengers and 460 gal. of fuel. Gross weight of the aircraft was well under the maximum allowable and its center of gravity was located within prescribed limits. The wind was calm and runway 14 (4,116 ft.), one of two macadam runways, was selected for takeoff. There is no air traffic control tower at New Haven.

After completion of the takeoff checklist, the aircraft moved onto the runway and takeoff was initiated from a taxi start without delay. This segment of the flight was being flown by First Officer Paquette who occupied the right seat. Capt. Johnson, on the left, maintained directional control during the inital acceleration of the aircraft. Before the aircraft reached the intersection of runways 14 and 19, the landing gear was retracted. The aircraft then skidded down runway 14 near its center and came to rest 1,050 ft. from the far end. Capt. Johnson, Stewardess Sullivan, and three passengers left through the right emergency escape hatch over the wing. First Officer Paquette and the two remaining passengers left through the partially opened front entrance door. Fire, around the left engine and the left outboard wing area, caused considerable damage and was extinguished by the local fire department.

INVESTIGATION

Capt. Johnson testified that just before reaching V_1 speed[2] he saw the left engine fire warning light come on and simultaneously heard the fire warning bell. He was watching the runway and the terrain beyond, occasionally glancing in the cockpit for airspeed indications.

His left hand was on the nose wheel steering control, his right hand at the landing gear selector location. He further said that following the observation of this fire warning, he looked back at the left engine and saw fire in the vicinity of the outboard residual heat door. He immediately called this to the attention of the first officer, remarking, "We're on fire, put it back down" or words to that effect, then retracted landing gear for a fast deceleration.

The left firewall shutoff valves were then closed and the CO_2 fire extinguisher for this engine was discharged. Retracting the wing flaps and accomplishing the remaining engine shutdown duties continued until the aircraft came to rest.

First Officer Paquette testified that he observed the airspeed indicator at 85 kt., at which time everything was normal and the aircraft was in a nose-up attitude ready to become airborne. He further testified he saw the left engine fire warning light and heard the warning bell after the captain remarked that the engine was on fire. At this time he had back pressure on the control yoke and was prepared to increase the angle of attack of the aircraft in anticipation of V_2 speed.[3] He held back pressure on the control yoke until the captain informed him of the fire, at which time he retarded the throttles, pulling them into the reverse position. Immediately thereafter the aircraft settled to the ground.

None of the five passengers observed fire until just before the aircraft stopped. Only one of the four ground witnesses said he saw fire during the early part of the takeoff roll. Another ground witness, positioned near this witness, said that he first saw smoke and fire when the aircraft passed the runway intersection, several hundred feet farther on.

The first impact marks on the runway were made by the tail skid and the bottom skin of the fuselage immediately forward of it. These marks started 1,380 ft. from the beginning of the takeoff roll and continued a distance of 1,686 ft. Propeller slash marks started about 120 ft. beyond the initial impact marks and continued for a distance of 343 ft. and 378 ft. for the left and right propellers, respectively. Initial slash marks were spaced 2 ft. 6 in. apart. The calculated ground speed of the aircraft at the time of ground impact, based upon the propeller slash marks and rpm. governor settings, was approximately 93 kt., 7 kt. below the V_1 speed of 100 kt.

The left and right landing gear doors were worn through. The skin around the forward lower cargo compartment was badly damaged and the lower portions of the structural frames were pushed upward and bent. Contact with the runway had also worn down the fuselage tail skid approximately one-half inch. An area just ahead of the tail skid and below the aft cargo compartment, from station 628 to 744, was also badly damaged. Fuselage belly was severely abraded due to sliding on runway.

The left wing and the outboard side of the nacelle of No. 1 engine were extensively damaged by fire. Portions of the inner wing from just outboard of No. 1 engine to the wing outer panel were extensively damaged. The entire left wing outer panel, which includes the left aileron, was burnt away. The upper wing surface from stations 188 to 323 was badly buckled because of heat. A section of a propeller blade, approximately 4 in. x 4 in., had penetrated the lower wing surface forward of the front spar, cutting through the front spar web and the No. 10 rib and puncturing the fuel tank. Fuel from this tank ignited and caused the fire. The right wing was essentially undamaged.

All of the blades of both propellers were bent rearward in varying amounts from runway contact, and approximately four inches of the No. 2 blade and five inches of the No. 3 blade of the No. 1 propeller were broken off. The No. 3 blade of the No. 2 propeller had approximately 12 in. broken off from the tip.

Investigation revealed that the left propeller dome piston was positioned at minus 13 deg., or full reverse relative to the blade angle, and the right propeller dome piston was positioned at 29 deg., the low pitch stop position. Shim plate indentations indicated blade angles at impact of 29 deg. for both propellers. The difference in blade angle between the propeller dome piston position of the left propeller and that of the shim plate indentations indicates that this propeller continued into reverse after ground impact.

The left engine and its propeller were found intact on the aircraft. Examination of this engine showed there was light fire damage in the areas of cylinders 2, 3, 16, 17, and 18. All engine accessories were in place and undamaged.

The left engine was removed intact from the aircraft and installed on a test stand where it was operated at 1,000, 2,000, and 2,800 rpm. These three rpm. settings were selected because they represented, in order, an average slow engine speed, an rpm. giving a manifold pressure equal to the standard barometric pressure, and the maximum takeoff rpm. All temperatures and pressures were found to be normal.

The engine was shut down after each run

[1] All times herein are eastern standard based on the 24-hr. clock.

[2] V_1 is the critical-engine-failure speed or the speed at which a sudden engine failure is assumed to occur and is the basis for determining the minimum required takeoff and acceleration-stop distance. This speed is the minimum speed at which the pilot has, in the case of engine failure, the choice of continuing or aborting the takeoff without exceeding the minimum required distances.

[3] V_2 is the takeoff-climb speed or the minimum safe takeoff-flight speed, with one engine inoperative.

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and examined for oil and fuel leaks and none were noted. The engine was then operated at dry takeoff power for approximately 30 min. and a corrected brake horsepower of 2,095 was obtained. The engine was also operated for 15 min. at wet takeoff power and a corrected brake horsepower of 2,330 was obtained. Fuel flow and ADI (antidetonation injection) flow rates were normal during these tests. During the entire test stand operation, which totaled approximately 1 hr. and 40 min., there were no indications of fluid leakage, engine roughness, or below normal performance.

The fire warning system on the left engine was checked for continuity and was found to be intact and capable of normal operation. Heat checking of the fire warning detectors revealed there was correct polarity. The fire warning control relay box was removed and installed in another Convair 240 and the fire warning system of that aircraft, when tested, operated normally. The control box was also tested for relay sensitivity and was found to be properly adjusted. All tests of the fire warning system showed it to be capable of normal operation. The operational checks of this engine and its fire warning system, together with the minor damage found, precludes the possibility of fire having occurred prior to ground impact.

Safety Solenoid Function

During the functional testing of the fire warning system in the cockpit, the landing gear safety solenoid was observed to be continuously energized. The solenoid is normally de-energized when the landing gear is extended and the weight of the aircraft is on the landing gear. The function of the safety solenoid is to prevent inadvertent retraction of the landing gear when the aircraft is on the ground.

The safety switch cover plate was removed and it was found that the circlip on the switch shaft, which positions the switch actuator arm, was missing.

This missing circlip allowed the actuator arm to move 7/16 in. from its normal position, permitting the switch contacts to remain closed.

In this condition, the defective safety switch energized the landing gear safety solenoid withdrawing the latch pin, thus allowing the gear selector handle to be placed in the "UP" position and the landing gear to retract even though the weight of the aircraft was on the gear.

Normally, the landing gear cannot be raised while the landing gear strut is compressed by the weight of the aircraft on the ground unless the latch pin, which protrudes through a hole in the landing gear selector handle, is depressed manually, permitting the handle to be raised.

Neither the captain nor the first officer was aware of this unsafe condition. The switch cover plate was polished by contact with the displaced actuator arm, indicating that this condition had existed for an extended period of time.

There were several entries in the pilot flight reports covering a period from Jan. 27, 1958, to Feb. 26, 1958, denoting that the safety switch had malfunctioned and had been repaired.

Since testimony of the flight crew and witnesses reflected that there had been no indications of maloperation within the right engine, no test stand operation was conducted. Visual examination of this engine indicated that all components were intact and that the engine was not damaged by impact or fire.

Weather was not a factor in this accident.

ANALYSIS

The captain said that before reaching V_1 speed in the takeoff roll he observed the fire, heard and saw the fire warnings, and decided to scuttle the aircraft to bring it to a quick stop. It is difficult to reconcile these statements with at least three facts.

The first is that having been a captain of Convair aircraft for more than two years and having acquired a total flying time of 4,660 hr. on this type aircraft, of which 1,322 were acquired as captain, it was his responsibility and therefore he should have known how the landing gear retraction system functioned; also, that under normal operating conditions, the landing gear selector handle could not be raised to retract the landing gear until the gear no longer carried the weight of the aircraft.

The second fact is that the statements of passengers and eyewitnesses, which are substantiated by the examination of the physical wreckage, do not support the presence of fire prior to ground impact. The third and equally important fact is that at the time of gear retraction more than ample runway remained to brake to a successful stop and even had there been a fire in the left engine no necessity existed for scuttling the aircraft.

The testimony of the captain is inconsistent with the clear and substantiated evidence of record in this investigation. Under the circumstances, the Board cannot accept the statement of the captain. The Board therefore concludes that fire did not occur until after the aircraft settled; that the captain, instead of intentionally raising the gear as he stated, not knowing that the safety switch was malfunctioning, actually caused the gear to be raised unintentionally.

Poor piloting technique was displayed by the captain in placing and keeping his hand on the landing gear selector handle and by his uncalled for action in applying an upward pressure on this lever in anticipation of the first officer's command to raise the gear. This accident would not and could not have occurred without the captain's improper procedure in applying upward pressure to the landing gear selector handle and malfunction of the landing gear safety switch.

As a result of this accident American Airlines issued a "Fleet Campaign Directive" which required an immediate one-time inspection of the landing gear safety switch assemblies on all of its Convair aircraft. Several other corrective measures designed to preclude further maintenance difficulties were also instituted with regard to the switch overhaul procedures. As an additional precaution the company restricted Capt. Johnson from flying as pilot in command for a period of six months.

FINDINGS

On the basis of all available evidence the Board finds that:

1. The crew, aircraft, and carrier were currently certificated and the flight was properly dispatched.

2. The aircraft load was well below maxi-

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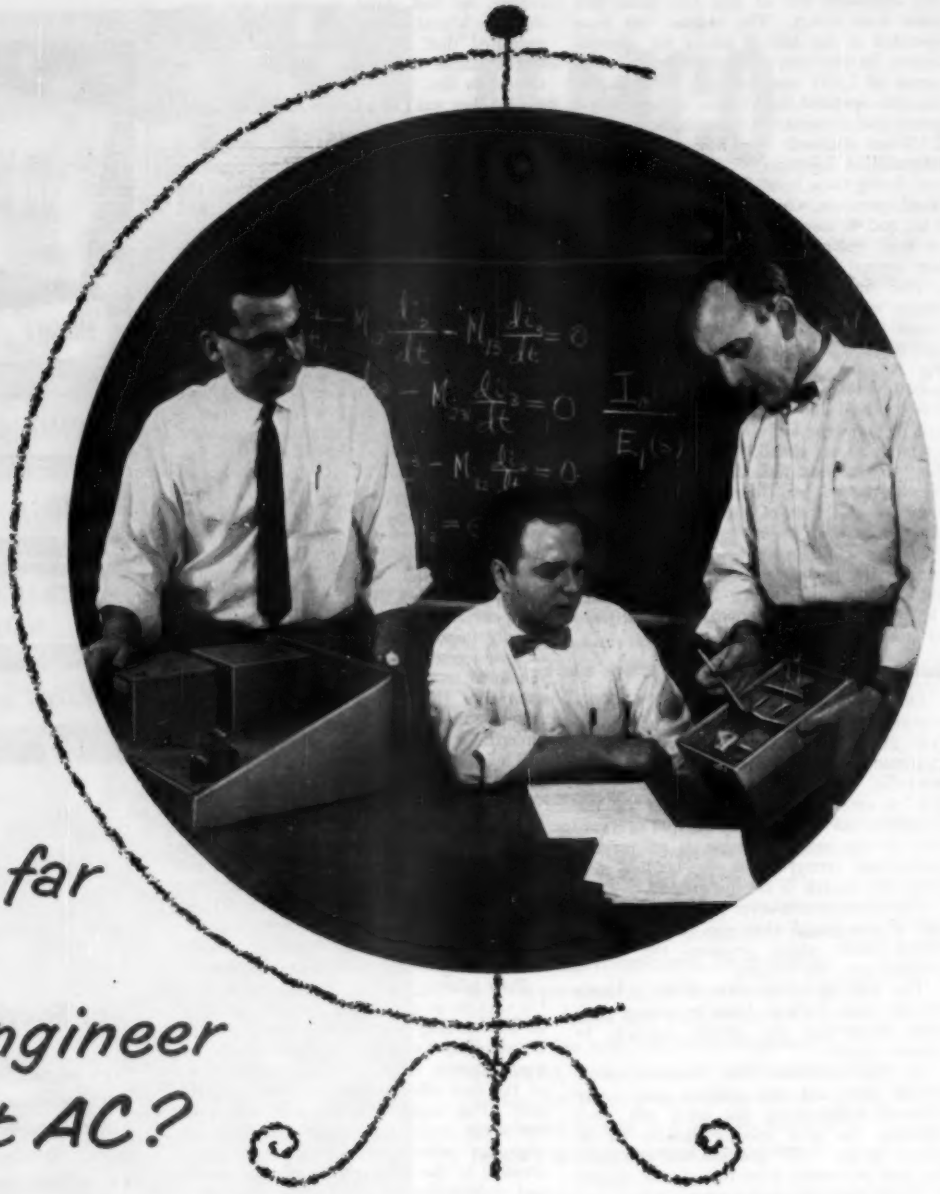

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mum allowable and properly distributed.

3. Weather was not a factor.

4. The first officer made the takeoff with the captain performing the duties of copilot from his left seat.

5. The aircraft operated normally up to 85 kt. in the takeoff roll.

6. The captain prematurely applied upward pressure on the landing gear selector handle.

7. A defective landing gear safety switch allowed the landing gear selector handle to be unlocked during ground operation of the aircraft, and permitted the landing gear to retract.

8. Fire did not develop in the left nacelle and fuel tank area until the aircraft skidded to a stop on the runway.

9. The company's inspection of the safety switch was inadequate.

PROBABLE CAUSE

The Board determines that the probable cause of this accident was the improper technique of the captain resulting in the unintentional retraction of the landing gear prior to V_1 speed, which was made possible by a malfunctioning left gear safety switch. A contributing factor was inadequate inspection by the carrier.

By the Civil Aeronautics Board:

JAMES R. DURFEE
CHAN GURNEY
HARMAR D. DENNY
G. JOSEPH MINETTI
LOUIS J. HECTOR

INVESTIGATION AND TAKING OF DEPOSITIONS

The Civil Aeronautics Board was notified of the accident immediately after occurrence. Investigation was started immediately in accordance with the provisions of Section 702 (a) (2) of the Civil Aeronautics Act of 1938, as amended. Depositions, ordered by the Board, were taken at New York, N. Y., on March 27 and 28, 1958.

American Airlines, Inc., is a Delaware corporation with general offices in New York, N. Y. It operates as an air carrier under currently effective certificates of public convenience and necessity issued by the Civil Aeronautics Board and an air carrier operating certificate issued by the Civil Aeronautics Administration. These certificates authorize the carrier to transport by air persons and property over numerous routes within the continental limits of the United States, including the route being flown in this instance.

Capt. Edward W. Johnson, age 37, was properly certificated for the flight. He had been employed by American Airlines for more than seven years. His total flying time was 7,453 hr., of which 4,660 hr. had been in Convair 240-type aircraft, 1,322 as captain. His required periodic examinations and checks were current and his rest period prior to the flight had been in compliance with CAA requirements.

First Officer Norman A. Paquette, age 32, was also properly certificated for the flight. He had flown approximately 5,300 hr., of which approximately 3,205 hr. had been in Convair 240-type aircraft. All of his required periodic examinations and checks were also current and his rest period prior to the flight had been in compliance with CAA requirements.

Stewardess Marian Sullivan was employed by the company on May 18, 1956. Her last emergency procedures refresher training was on Nov. 20, 1957.

THE AIRCRAFT

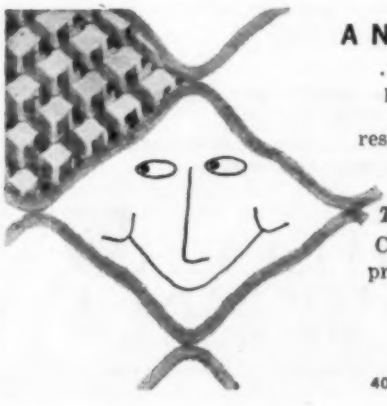
Convair 240, N94213, serial number 23, was acquired by American Airlines Jan. 18, 1949. Since that time it had been flown 20,857 hr. The aircraft had 63 hr. since the last periodic check, and 1,868 hr. since the last continuous airworthiness check at Tulsa, Okla.

The engines were Pratt & Whitney R2800-83AM4A. Engine No. 1, serial number 56710, had a total of 15,761 hr.; engine No. 2, serial number 54505, had a total of 17,037 hr. Both engines had 157 hr. since last overhaul.

The propellers were Hamilton Standard, model 43E60, blade model 6895A-12. Propeller No. 1 had 1,866 hr. since last overhaul and propeller No. 2 had 1,868 hr. since last overhaul.

USAF to Evaluate F-102 As European Interceptor

Operational tests of Convair F-102 interceptor will be conducted by USAF in Europe to see how the aircraft fits into Europe's defense needs. Several F-102s recently were sea-freighted to St. Nazaire, France, for de-mothballing by Sud Aviation. Tests will be carried out at Ramstein, Germany.



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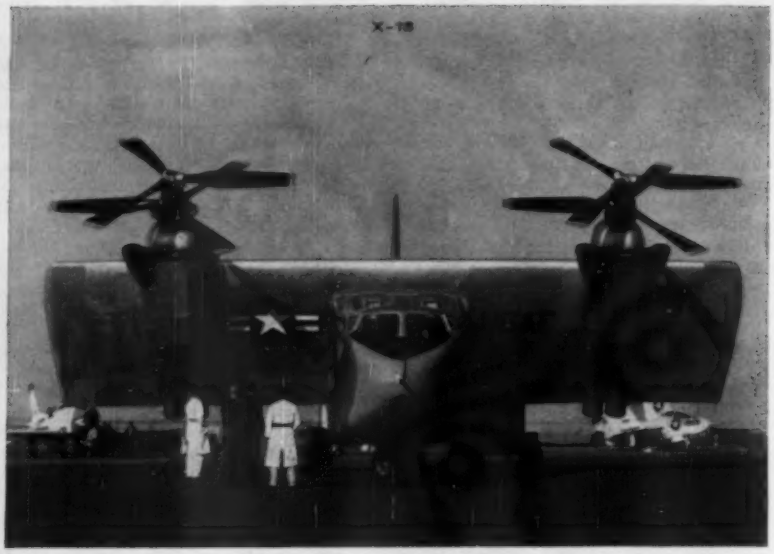

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WHO'S WHERE

(*Continued from page 23*)

Honors and Elections

Harvey Gaylord, president of Bell Helicopter Corp., has been named chairman of the Helicopter Council of the Aircraft Industries Assn. for 1959. **J. E. Leonard,** manager-military requirements of Cessna Aircraft Co., will serve as Council vice chairman, and will succeed Mr. Gaylord as chairman in 1960.

Changes

Dr. Patrick Conley, manager, Westinghouse Electric Corp.'s Air Arm Division, Baltimore, Md.

Harry E. Gravlin, Jr., production manager, Hamilton Standard, division of United Aircraft Corp., Windsor Locks, Conn.

Arnold R. Anchordoguy, associate program director-Thor weapon system, Space Technology Laboratories, Inc., Los Angeles.

Brig. Gen. Frederic L. Hayden (USA, ret.), consultant for the Defense and Technical Products Division, Rheem Manufacturing Co., Downey, Calif. Gen. Hayden will be located in Rheem's Washington, D. C., office.

Leonard R. Ambrosini, head of the newly formed Analytical Engineering Department, Astronics Division, Lear, Inc., Santa Monica, Calif.

Dr. Walter Muller and **Dr. Vladimir Vodicka,** senior members of the applied research staff, Lenkurt Electric Co., San Carlos, Calif.

General Electric Co.'s Production Engine Department, Cincinnati, Ohio, has established two new groups and made the following appointments: **N. E. Frischhertz,** manager, Product Service Section; **M. P. Fages,** manager, Engine Rebuild Section.

Vincent Prus has been placed in charge of the Subroc production program, Goodyear Aircraft Corp., Akron, Ohio.

Dr. William L. Davidson, technical coordinator-rocket propellant activities, Food Machinery and Chemical Corp., San Jose, Calif.

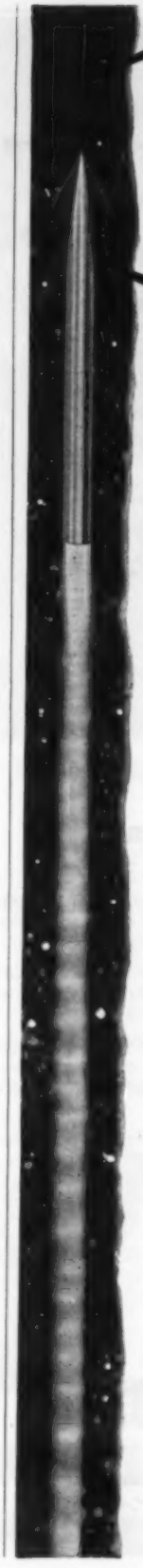
S. J. Colby, assistant to the vice president for engineering-missiles and space systems program, Douglas Aircraft Co., Santa Monica, Calif.

Dr. James Ford, head of the Applied Physics Department, Cornell Aeronautical Laboratory, Buffalo, N. Y.

Dr. Ronald Bell, senior research physicist, Greer Hydraulics, Inc., Jamaica, N. Y.

AC Spark Plug Division of General Motors, Milwaukee, Wisc., has created four new engineering departments and made the following appointments: **Bruce H. Schwarze,** director, Commercial Engineering; **Donald F. Ayres,** director, Gyro Components and Engineering Services; **Dr. Joseph F. Shea,** director, Advanced Systems Engineering and Research; **Dr. James H. Bell,** director, and **Robert G. Brown,** associate director, Guidance and Navigation.

Dr. John G. Meitner, head of the analysis and research section, Launchers and Power Plants Department of Hughes Aircraft Co.'s Guided Missile Laboratories, Culver City, Calif.



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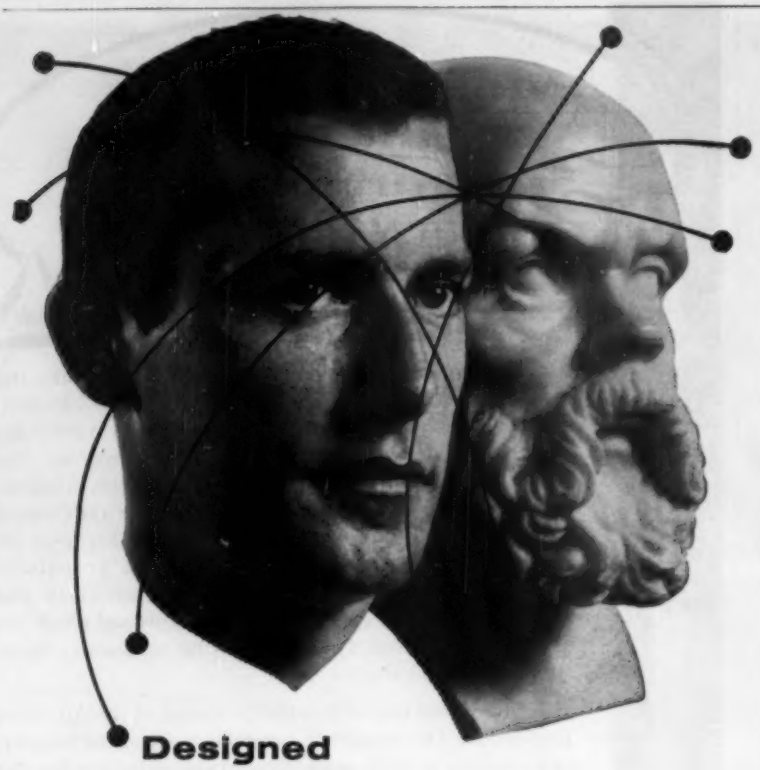

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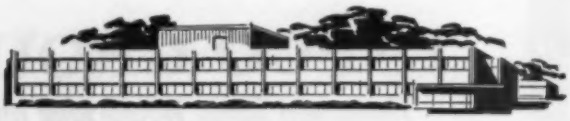

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LETTERS

Engineering Decisions

Thanks to J. K. Gerdel (AW Dec. 22, p. 86) for unwittingly expressing the seldom written philosophy underlying much of our aeronautical engineering management today. He proposes that ". . . the void which exists between . . . management . . . and . . . development" be filled with more " . . management of engineering personnel by non-engineering qualified managers."

Of the five aircraft firms which employed me, two had chief engineers who had neither engineering degrees nor the ability to express themselves in terms which were understandable to engineering groups. The result was inefficiency, confusion, and low morale. On the other hand, I never heard of a single hospital where the chief surgeon had no medical degree, and I never expect to.

Why is it that so many people who wouldn't dream of impersonating other professionals try so hard to get where they can make engineering decisions on problems they know very little about?

W. H. R.
Connecticut Engineer

Budget vs. Defense

Mr. J. E. Hart, in his letter published in AVIATION WEEK (Dec. 29, p. 82), has made the following points:

1. Increase of the national debt will lead to bankruptcy and, therefore, to communism.

2. The public's "need to know" automatically implies disclosure of all details of all defense measures.

3. President Eisenhower and all other "men in high places" know what is good for us and should not be questioned or criticized.

Because the sentiments contained in the above items are, in my opinion, dangerously widespread, I should like to answer by saying that:

(1.) Bankruptcy will occur if the creditors storm the teller's window and demand their money back. This is not likely to happen if the creditors are satisfied that the "bank" will not be forced to close because of a military defeat. The "bank," therefore, must provide itself with adequate defenses; this requires the expenditure of vast sums and budget-balancing must, of necessity, be given a lower priority.

(2.) The public should be given some idea of our defense operations. Else, how could we vote for or against politicians whose work on defense legislation was unknown? We would also be ignorant of the state of our defenses, in which we would play a part if the balloon did go up. Of course, it's possible we're too stupid to be allowed to know. That's a point for Mr. Hart to consider. Or has he already considered it?

(3.) Let us assume that the "continual sniping at our popularly chosen government men in high places" stopped today. What caliber of work would result? I dread to think. To use Mr. Hart's favorite whipping boy, criticism of government officials in you-know-where has been discouraged in every possible way and the results are plain to all.

Mr. Hart has said that "under the Communist system you'd only write one and final editorial like "The Need to Know." This is quite true, and under the system he proposes you would not have written it in the first place.

H. D. RANZENHOFER
New York, N. Y.

Hurray for Mr. J. E. Hart (AW Dec. 29, p. 82).

Mr. Hart "hit the nail on the head" in every respect. We can and must have an adequate defense, but we must live within our means. Why are you so naive to think that our country can continue to spend more than we take in without disastrous results?

The balanced budget of an economically strong country will be a much more effective force in deterring our enemies' plans than the strongest military force of a country that experienced the chaos, and ruin, brought about by bankruptcy.

BRADFORD HALL
Assistant Vice President
Union National Bank
Wichita, Kan.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Laurel for Caldara

Your recognition of the achievements of Maj. Gen. "Smokey" Caldara reflects discerning observation, clear knowledge of what's going on, and meritorious judgment. I'm writing of your editorial, "Laurels for 1958," Dec. 22, 1958 issue of AVIATION WEEK. My kudos to you may sound like a tired citation but believe me they were never said with more sincerity.

Flying safety, accident prevention—call it what you will, is an unending, usually unpopular, often gruesome endeavor. In the three and one-half years I served under Gen. Caldara in the Directorate of Flight Safety Research, I often thought it was truly "wrong business" literally and figuratively. A crash inherently implies the crew was wrong, or the crew chief was wrong, or the designer was wrong, or the manufacturer, or the metallurgist, or the navigation aids, or the weather, or the runway, or even the time was wrong. Sensitive interests inside and outside the Air Force are pricked. Fingers are pointed. Reputations totter. The press and public opinion are often stirred. Because of these nuances of evil, people tend to look the other way; sweep the problems under the rug; hope that crashes will go away—finally complacency.

So the biggest job of the Flying Safety Officer—the fall guy for accidents—beginning with Gen. Caldara and extending down through the 1,200 or so FSO's in the Air Force, is the battle against complacency. It is here that he has done the terrific job that you so justly recognize. He has developed safety consciousness within the Air Force (and other services), the aviation industry and allied fields that, in retrospect, is unbelievably far reaching.

Further, in my opinion, he's respected and even admired by those whose actions or inaction, policies, or products he's been required to criticize with "blunt diplomacy."

This unsolicited expression of gratitude to you is forwarded only because I finished my tour with him last September. He's my ex-boss; no longer signs my efficiency report; has no way of repaying.

Again, my compliments to you and your fine magazine for recognizing the outstanding results of a very deserving officer in a most difficult job. Paradoxically, to my knowledge, no one has ever said to him, "Thanks for saving my life."

USAF COLONEL
MATS, Scott AFB, Ill.

GCA Technique

Your article on flying the Lockheed Electra was highly informative (AW Dec. 22 p. 56, and Dec. 29, p. 53).

I would like you to note a discrepancy with regards to technique in flying GCA approaches. Your writer mentions "Radar steers were somewhat excessive . . ." and that "AVIATION WEEK's pilot soon developed the knack of slight undershoots on steering headings given."

Inasmuch as your magazine is so widely read and looked to as an authority on subjects it prints, I draw exception to this "knack" your pilot developed.

The GCA operator gives headings to compensate for wind drift, and quite probably on a long approach as mentioned and in a letdown into a valley there would be considerable change in wind direction or velocity. The proper method for the pilot to use is to fly the heading given and not make up any of his own. By so doing the GCA controller will know if he has properly determined wind correction, but if the pilot flies some other heading it will be reflected on the radar scope as either too much wind correction or not enough; the controller, not realizing that this error is not really his, will give further correction resulting in overcontrolling by the pilot and overcorrecting by the controller.

It takes a good controller and a good pilot to make a good GCA approach.

VICTOR J. HANCOCK
Collins Radio Co.
Cedar Rapids, Iowa

Parts Identification

Re Mr. Nitikman's comment (AW Dec. 29, p. 82), there is a little sign often seen in industrial and military establishments everywhere, i.e. "No Name, No Tag, No Part Number; What the Hell is it?"

Whether computed in terms of dollars or in terms of weight penalty, the need for proper and adequate parts identification remains necessary.

W. L. THIER
San Francisco, Calif.

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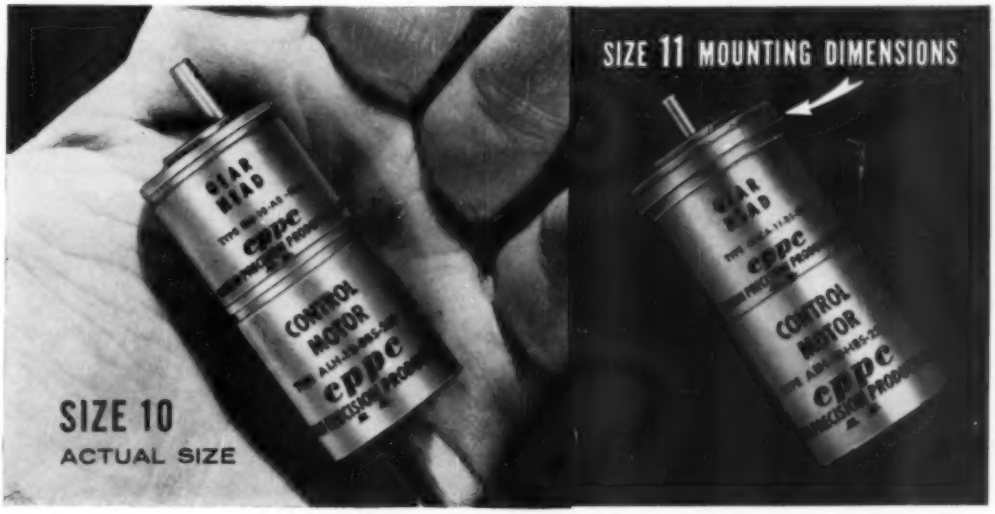

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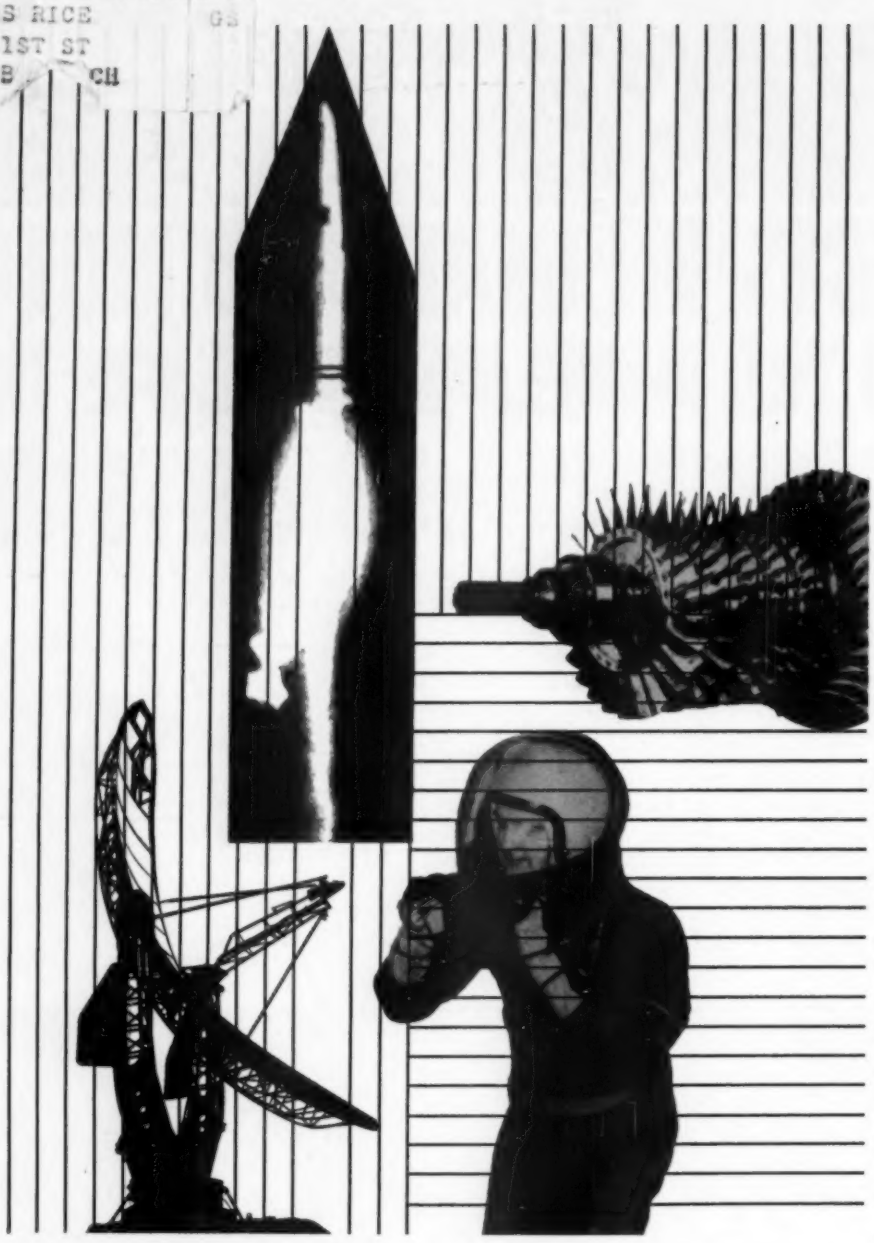

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